THE SHIPBUILDING INDUSTRY

KELLY & ALLEN

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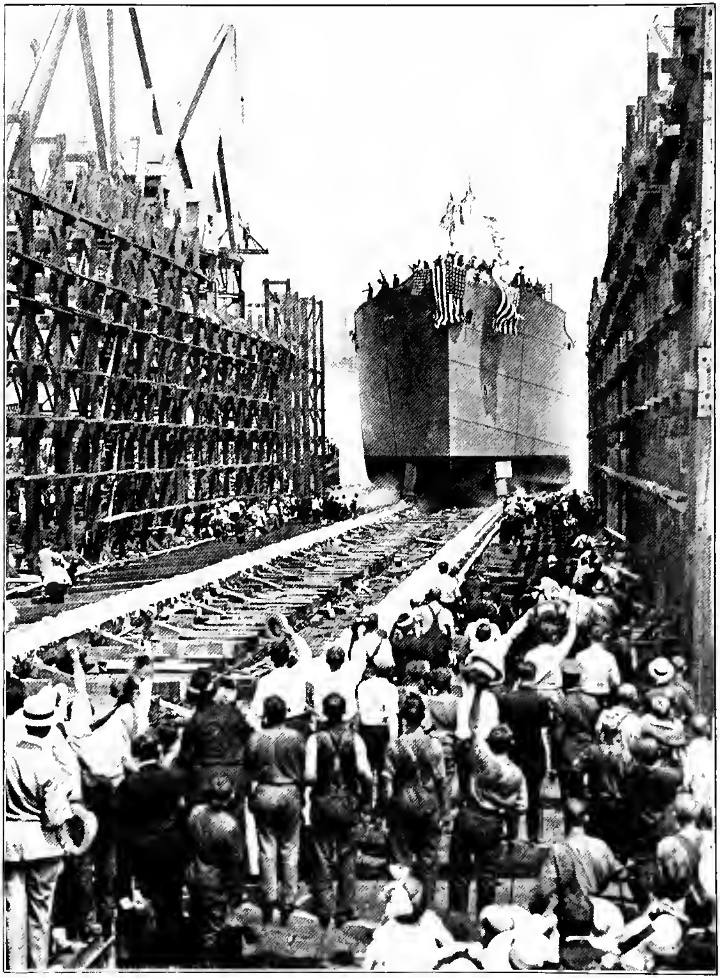

THE LAUNCHING OF A STANDARDIZED VESSEL

The psychological moment when the success of the launching is assured If the ship has not been properly built and properly launched it begins to list at this point

THE SHIPBUILDING INDUSTRY

BY

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WITH AN INTRODUCTION BY
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PREFACE

An army of more than 625,000 men is now employed in the shipyards or in the manufacture of machinery and fittings for ships. Recruiting and organizing this army, building the shipyards in which they are to work, and starting in motion the great streams of steel and other materials for shipbuilding constitute a task of enormous proportions. Since ships are vitally necessary to our whole war programme, the fact that this task has been so well begun ought to be cause for gratification to every patriotic citizen. It is the primary purpose of this book to describe and interpret our war-emergency shipping programme and the task of the shipbuilders, for the general public as well as for those employed in the shipyards.

A large number of persons must still be found who are capable of becoming a part of this great undertaking, men who understand that some hardships and sacrifices may be involved, but who are willing to keep steadily at work until the present crisis is over. There are, undoubtedly, thousands of men throughout the country whose experience and general qualifications especially fit them for such service. It is hoped that this book will help them to decide for themselves whether or not they are qualified to undertake any of the work which it describes.

Some of the chapters will also be helpful to those who wish to prepare themselves for executive positions and to young men who are considering shipbuilding or naval architecture as a possible life calling. Many men are being drawn into the shipyards who are being taught a trade for the first time. Others are being transferred to the yards from similar mechanical pursuits outside of

shipbuilding. Only a few of these men will have any chance through their daily routine to become acquainted with the way in which the work of the yard is organized or with what is being done in other departments. For those who are seeking opportunity for advancement, knowledge of this kind is quite essential. All executives, and especially foremen, instructors, superintendents, and members of employment and service departments, ought to have clear ideas of the parts played by the various divisions of the concern and of the demands made upon those employed in them. Executive organizations cannot become wholly successful unless the men who are brought into them are of the right type and have a clear understanding of the problems confronting them. The account of the shipbuilding trades offered by this volume should help any progressive man in placing himself abreast of his task and in gaining an insight into his relation to the industry as a whole.

The parts of the book dealing with the shipyard occupations represent the best judgment of trained men who have visited the yards and talked with skilled workmen and others who know every detail of the different trades. Thanks are especially due to the Industrial Service Section of the Emergency Fleet Corporation for permission to reproduce parts of the booklet, *Shipyard Employment*, which was prepared some months ago by the Harvard Bureau of Vocational Guidance. Professor Erwin H. Schell, of the Massachusetts Institute of Technology, and Superintendent George C. Minard, of the Arlington Public Schools, have assisted in collecting information regarding the shipyard trades.

ROY WILLMARTH KELLY

CAMBRIDGE, *September*, 1918

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INTRODUCTION

BY CHARLES M. SCHWAB

Director-General United States Shipping Board, Emergency Fleet Corporation

By the time this volume is ready for the reader, ships will have done their part in winning the war and will be taking up the work of keeping the American Flag on the high seas of commerce. It has been a great privilege to participate in the building of ships to meet a great world emergency.

Once again the United States is to take her place as one of the leading maritime nations of the world — not because of careful forethought on our part; not because we looked ahead to after-war profits; but because our Allies needed help and because ships were necessary that the help might be rendered. I like to feel that our emergency marine, transformed into a mercantile marine with the coming of peace, will be the more prosperous because it grew in the time of need and was built to further the most righteous cause which the world has ever known.

When the need arose and it looked as though the war might be lost through inability to get American men and supplies to the battle-front, there were few shipyards of any productive capacity in the United States. Almost overnight vast plants began to appear along the three coasts and on the shores of rivers and lakes. An army of men turned shipbuilders, some having trades which enabled them to fit into necessary places with little in-

struction, and others with no mechanical knowledge whatsoever being turned into highly skilled artisans.

In every respect the result was a national achievement, but if special credit is to go to any group of men, it is to those who wore overalls and jumpers, who drove rivets or who hewed timbers.

In the matter of supplies and the shipping to carry those supplies, our Allies will give America the fullest credit, and in her achievement along these lines the building of ships looms large.

Let us keep that which necessity has given us; let us study and continue to develop the building of ships; let us see to it that never again shall the American mercantile marine be absent from the high seas.

THE SHIPBUILDING INDUSTRY

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CHAPTER I

A GREAT NATIONAL ENTERPRISE

THE most significant fact that confronted the United States, upon the declaration of war in 1917, was the existence of a barrier of three thousand miles of sea between us and the battle lines of Europe. Even with our inexhaustible national resources, we could have entered the war effectively only by the use of ships, thousands of ships, ships of all kinds and capacities.

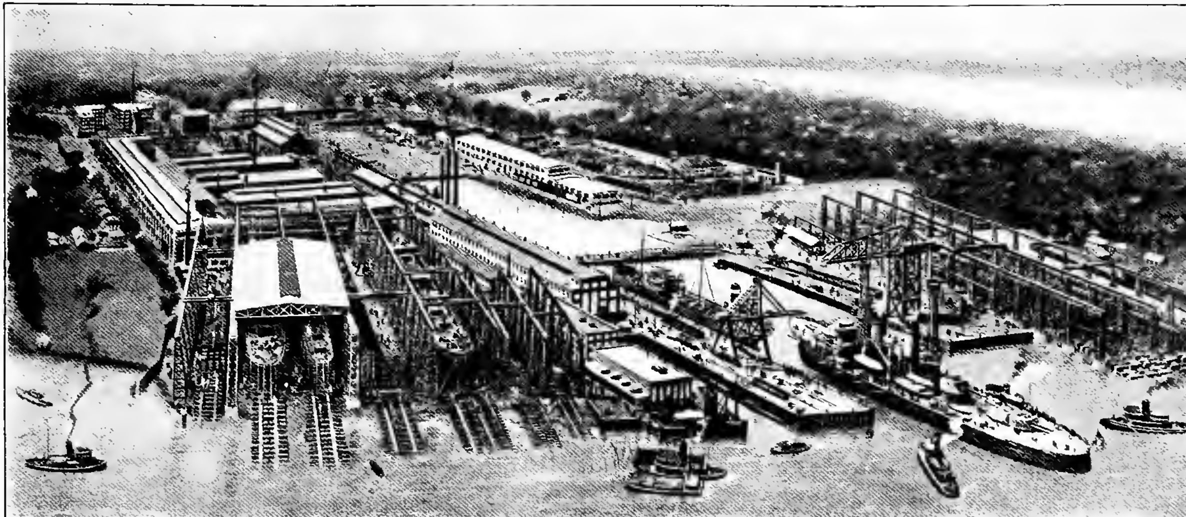
We faced a nation in arms whose leaders declared it to be "the duty of every one who loves languages to see that the future language spoken in America shall be German." The enemy had consistently preached the doctrine that "not only North America, but the whole of America must become a bulwark of Germanic Kultur, perhaps the strongest fortress of the Germanic races!" It was only by degrees that the American people were brought to believe that Teutonic military authorities were in earnest when they proclaimed it to be their intention, after finishing the war in Europe, to "take New York and probably Washington and hold them for some time." German books, periodicals, and private correspondence between Germans in this country and at home have teemed with such sentiments, sentiments that express not only individual opinion, but an intense and long-established national purpose of world domination with America as the seat of German power.

But in spite of the response of the American people from coast to coast to such a challenge, our first duty and impulse were to assist France, Belgium, England, Italy, and those other unfortunate lands that for three years had stood stanchly as the bulwark of our liberties as well as their own. Their soldiers were now our brothers in arms. Ties were being formed, bonds were being welded, that would make our peoples one in experience, in loyalty to ideals, in aspirations and hopes, and in fealty to Right and Liberty.

The crisis called for men, measures, and materials. As this is being written the marching of our men in camp and field is heard throughout the world; twenty millions of our people have contributed billions in Liberty bonds, and leaders in business and industry have voluntarily entered the councils of the Nation; materials we have in abundance for our own needs and for the need of our Allies.

We are fighting the enemy quite as much with materials as with men. Indeed, authorities claim that the most urgent need at the present time is for materials. Belgium and England are calling for food to sustain women and children at home, as well as troops on the battle line. Italy needs coal and France needs steel. All the Allies are in dire need of railroad materials, munitions, clothing, and a great variety of other war supplies. We are shipping a great army to Europe, numbering a million and a half of men, perhaps two million within the present year. Five tons of material must be transported yearly for each soldier, for a successful waging of the war. Thus many millions of tons of supplies for our troops and for the Allies must be sent abroad in 1918.

How are we to get such numbers of men and quantities



THE FORE RIVER PLANT OF THE BETHLEHEM STEEL CORPORATION, QUINCY, MASS.

(Before Recent Enlargements Were Made)

Shops and mills occupy the long buildings. In the foreground are the berths or ways in which ships are constructed and from which they are launched. To the right of the center foreground are the outfitting piers where the ships are finished and the machinery is installed after launching

of material across the three thousand miles of sea? The task would be of the greatest difficulty even in times of peace. Now it must be accomplished in the face of a relentless submarine warfare. The danger of the submarine may be now ended, but German mines and U-boats destroyed at a maximum half a million tons of shipping every month. This loss must be made good by building new ships, and additional ships in great numbers must be built by this country as fast as our yards can turn them out.

Regardless of our share in the war, we must continue to send food to the European nations. On March 5, 1918, the United States Food Administration announced that, from the opening of the war up to January 1 of this year, food sufficient to furnish a balanced ration for more than 16,000,000 men yearly had been shipped by this country to the Allies. What a service, then, have the ships already rendered, to carry food enough to more than feed the Allied armies in the field!

Russia received less than one per cent of the total, or only enough to feed about 100,000 men a year. Great Britain took more than half of the entire total, or enough to feed about 8,000,000 men. France was next with enough for 4,200,000 men, and Italy had sufficient for more than 2,000,000 men.

The total export of wheat and wheat flour to Great Britain, France, and Italy was equivalent to 384,000,000 bushels, or an average of 110,000,000 bushels per year. Oats exported for the three and one half years totaled 212,751,000 bushels; corn, 24,310,000 bushels; and rye, 3,618,000 bushels.

Exports of fresh beef amounted to 443,484,000 pounds in the three and one half years, while exports of butter

totaled 29,000,000 pounds, cheese, 103,500,000 pounds, and condensed milk, 126,000,000 pounds; cottonseed, linseed, and other oil products and by-products to be used for feeding cattle totaled 611,000,000 pounds.

These quantities of food products, great as they are, must be increased while the war lasts and continued for some time at its close, while European agriculture is recovering.

The immediate building of ships is absolutely imperative. Troops in training in our camps and war materials swelling our storehouses are of no use unless transported to the seat of war. In the words of General Pershing, "We must build a bridge of ships across the Atlantic."

An outline of material prepared for "Four-Minute Men" by the Committee on Public Information at Washington states that our ships must do the following things:

1. Carry food and munitions to our Allies while we train our army.
2. Transport our army as it becomes ready and keep it supplied with food, clothing, guns, and ammunition: 2,000,000 men will require 1260 ships equal in size to the largest American liner.
3. Bring our imports for steel-making, wool-making, and our other uses:

   175,000 tons of chrome ore from New Caledonia.
   700,000 tons of manganese from South America.
   1,500,000 tons of nitrates from South America.
   1,200,000 tons of pyrites from Spain.
   3,000,000 tons of raw sugar from Cuba and Porto Rico.
   200,000 tons of wool from Australia and the Argentine.
   1,000,000 bales of hemp from the Philippines, etc.

In 1914, before the war began, cargo steamers were chartered for trans-Atlantic travel at one dollar a dead-weight ton a month. Two years and one half later, and

several months before we entered the conflict, the charge for carrying, even outside of the war zone, had risen to an average of $13.88 per ton a month. Within the danger zone, the charter rates went up to $20 and $21, and vessels were not easy to secure even at these figures. In the spring of 1914 cotton was shipped from Savannah to Liverpool at the rate of thirty-five cents per hundred pounds; three years later, the cost was $6 per one hundred pounds. Through the same period marine insurance rates were greatly increased. Cargo and insurance rates became almost prohibitive, and made the costs of our manufactures extremely high for the Allies who were already burdened to the breaking point at home.

Even during the early years of the war, American manufacturers were producing munitions and other war supplies, in great quantities, for the European Powers. It was early recognized that America must become the granary and storehouse of the Allied nations. American private capital, which had long been invested in domestic ventures, such as bonds and real estate, and indifferent to overseas commerce, at once awoke to the financial possibilities of investments in shipping.

Vessels were diverted from other trades to war commerce. Old steamers, long since regarded as unseaworthy, were repaired and sent into service, and others, including the interned ships of the Central Powers, were transformed into freighters and transports. Such transformation was made extensively in our shipyards. Old shipyards began building at full capacity, and many new ones were projected.

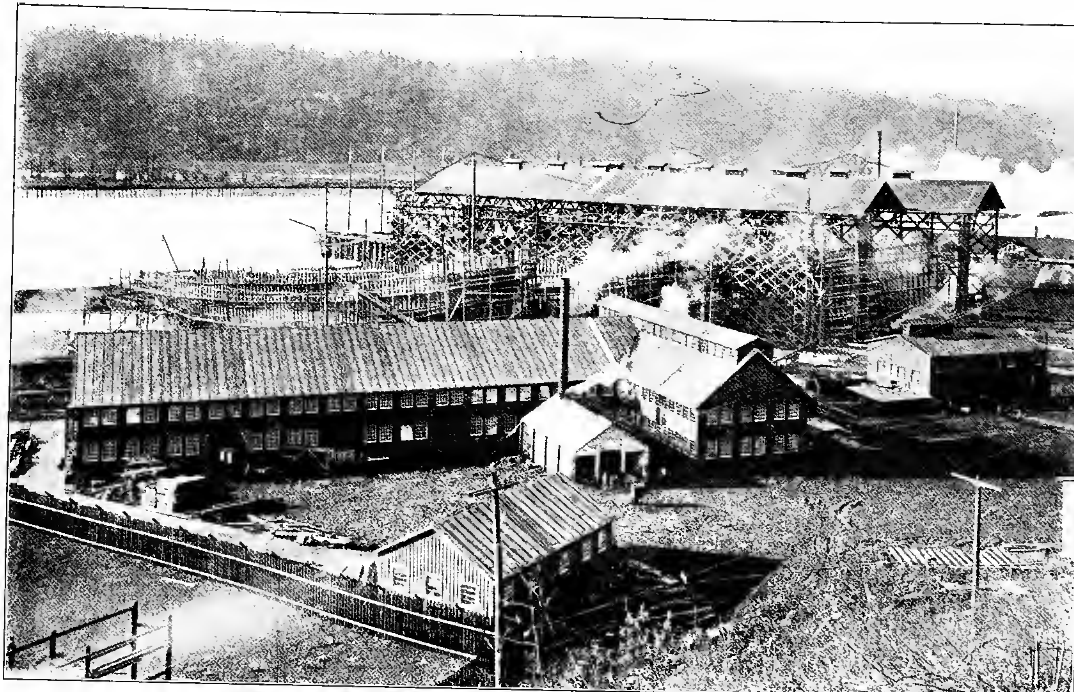
Renewed and aroused interest in shipbuilding in this country and an abundance of ready capital, while offering the highest encouragement, really brought the great-

est cause for anxiety. Unregulated high shipping rates under private control might nullify the best efforts of the United States to aid the Allies. In addition, the private shipbuilders were practically unable, without Federal assistance, to secure, train, and hold enough workers to build the thousands of ships which must be immediately constructed. Furthermore, it has long been realized that the country stood in great need of a revival of its merchant marine, and Congress had taken action early in the war to foster this. It now became clear that the Federal Government alone had power to organize and finance such a revival of shipbuilding as the crisis demanded.

The United States Shipping Board was, therefore, created at the beginning of 1917 to take charge of extending the merchant marine by acquiring ships and by building ships, of regulating shipping charges, and of conducting the merchant marine.

The Emergency Fleet Corporation, a subdivision of the Board, was organized about four months later for the distinct purpose of building ships, for more immediate efficiency, and for active coöperation with privately owned and operated companies. Indeed, the ships building by private companies have now been requisitioned by the corporation.

The Emergency Fleet Corporation is not a private corporation in the usual understanding of that term. It is not obliged to earn dividends upon its stock of $50,000,000 which is held entirely by the United States Government. The Emergency Fleet Corporation is not a charity, like the Red Cross; nor is it a distinct division of the service, like the Army or Navy. Its work is to produce the largest number of serviceable ships, under American



A WOODEN SHIPYARD AT PORTLAND, OREGON, OWNED BY THE PENINSULA SHIPBUILDING COMPANY

Oregon leads the United States in the number of wood hulls launched under the Fleet Corporation programme. The best speed records on wooden ships have all been made on the Pacific Coast

conditions of labor, in the shortest possible time. To the original plan of an organized and country-wide building of the merchant marine, there has been added the great demand for battleships, destroyers, submarines, and other ships of war.

The Emergency Fleet Corporation has, therefore, built up a great emergency programme, whose chief features are the construction of shipyards, the training of workers, and the building of merchant ships.

With the navy yards of the country, already under Government control, the Shipping Board has nothing to do. It has, however, through Government action, full control over the shipyards of the country, now, in August, 1918, 203 in number, and distributed through more than twenty-five states. These yards have 871 ways, in each of which a ship can be built. An average-sized steel vessel can now be made ready for launching in about two months. The average number of launchings each year of all kinds of ships will be about three to each way, or one vessel every four months. Nearly one hundred of these yards have been constructed since the first day of January, 1917. Still other yards will be constructed within the present year.

The shipbuilding programme calls for hundreds of wooden ships, which can be used advantageously in coastwise trade and for commerce outside of the war-zone, and thus release steel vessels for overseas use. The old wooden shipyards of the country have now become active and many new ones have been established. In this branch of the industry the South is rapidly coming to take a very important part. Its excellent lumber supply gives it an especial advantage over other sections of the country in producing wooden ships.

Over 100 enemy ships have been seized in our harbors, and over 800 vessels built and building, have been requisitioned from private ownership, making about 1000 put into relatively early service. More than 1500 cargo ships are now under construction or contract for Government use. Pending the completion of these vessels, it is estimated that the new limitations on foreign trade will immediately add 1,000,000 of tonnage for transportation of troops and supplies.

The plan of licensing exports and imports gives the United States virtual control over the world's shipping, neutral as well as Allied, because no vessel can carry any goods except those specified by the Government; and, of course, only the essentials for carrying on the war will be permitted to enter or leave our ports. Hereafter, even Allied merchants, who heretofore have been given practically free rein to carry on business not necessarily essential to war activities, will be subject to control; and our products will be diverted abroad only for the explicit purpose of aiding the Allied military programme.

The most urgent problem in our shipbuilding plan is that of men. At the beginning of 1918 about 250,000 employees were engaged in the work of the shipyards throughout the country, and on a conservative estimate this number must be increased to 500,000 within the year. If we take into account the turnover of labor, which unfortunately is found in the yards as well as elsewhere, to get the added number it may be necessary to hire 1,500,000 men.

At the Shipyard Employment Managers' Conference in Washington in November, 1917, Admiral Capps made this significant statement: "In 64 yards of which we have recently had accurate data, the turnover averaged 235

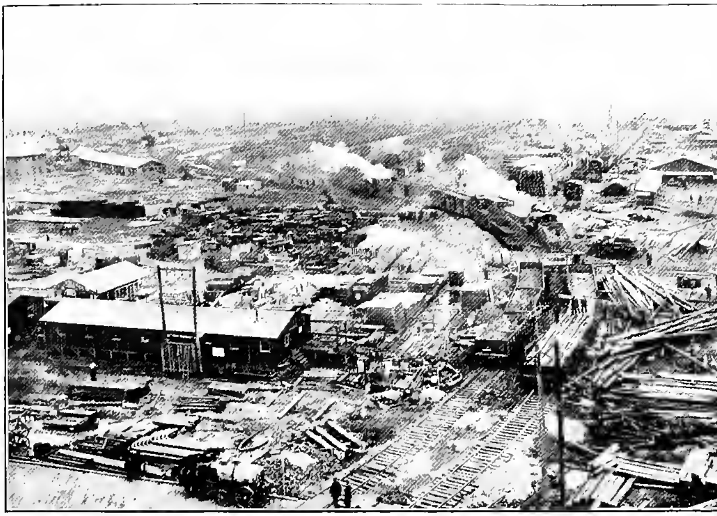
per cent, and was probably over 300 per cent at the last report. This means that for each 100 men on the average pay rolls of the yards, 300 men were hired by the employment offices during the year. You can well realize how large a volume of men is passing through our works in the course of a year without any adequate return in labor." Without doubt this proportion would hold true in the other yards, as well as in munition factories, and similar manufacturing establishments holding Government contracts. This fluctuation of labor has, indeed, constituted the most serious menace to progress in the prosecution of the war. As a consequence, after more than a year's experience and study of the problem, the United States Employment Service has been created and put in full charge of unskilled labor recruiting and supply for war industries. This plan went into operation on August 1, 1918. Every employer and every wage earner was asked to coöperate. The Employment Service has a director of its Public Service Reserve in every state. Each director must provide a given number of workers, enrolled in his state, toward the total demand of the war industries for common labor. It is compulsory on employers of more than 100 persons, having Government contracts, to secure workers through the United States Employment Service. Thus shipyards and factories are to be kept supplied with workmen drawn as far as possible from their own localities, and the flotation of labor is to be held in check.

Many of the larger yards employ from 6000 to 15,000 men each. The Submarine Boat Corporation at Newark, New Jersey, has 14,000 employees. The largest of the yards, the Hog Island Plant near Philadelphia, which cost over $50,000,000 to build, employs over 28,000 workers.

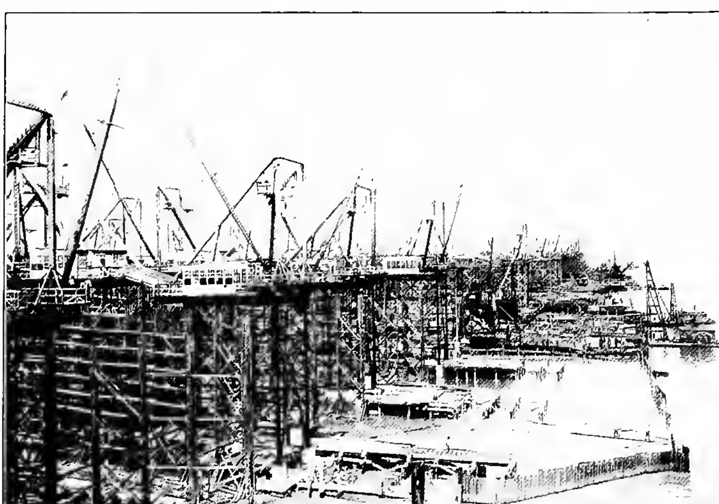
Not only must great numbers of workmen be found, but they must be trained to new work or to work under new conditions, and such provision must be made for their welfare that they may be kept constantly and contentedly at their task.

Provisions for training yard and shop instructors are now well under way, in the schools established by the Shipping Board at Newport News and in many other yards. The work of these schools is based in part on the material and methods of instruction in other kinds of industrial training. Instructors and capable craftsmen are selected and sent from the various yards to the yards in which the courses are given. After a six-weeks period of intensive instruction in the art of teaching others, they then return to their own yards and undertake the task of training new employees in the shipyard trades. Some yards, such as Harlan and Hollingsworth and the Chester Shipbuilding Company, have coöperative school courses for shipyard workers. Pratt Institute, at Brooklyn, New York, has established a course for training workers for wooden shipbuilding. Training for boys and young men who expect to enter the steel yards is being given in a number of schools, such as the Stuyvesant High School in New York City and the San Pedro High School near Los Angeles.

The Emergency Fleet Corporation is doing its best to establish and maintain conditions that shall give contentment to workers throughout the yards. The Industrial Service Department of the corporation early labored to bring about the best possible living and working conditions not only in the shipyards, but in the communities in which they are located. In some localities whole communities are being built up about the yards, with



HOG ISLAND DURING THE CONSTRUCTION PERIOD
A view of the storage yard from the central fire station



A PART OF THE SHIPWAYS AT HOG ISLAND

new buildings for housing, and modern water and drainage systems. For the workers in the Hog Island Shipyard over 5000 dwelling-houses have been constructed.

After it became evident that existing housing facilities in and near the shipyards were entirely inadequate for the great number of men being set to work and to be hired in the near future, Congress made an appropriation of $50,000,000 for the housing of shipyard workers. The exorbitant rents charged by the owners of private property in the neighborhood of the yards, and the entire lack of available houses in many places, made such action all the more necessary. The Government found it necessary to commandeer houses for the workers, or build them, in forms ranging from the barracks hastily constructed for the workers who built the new yards to modern cottages that may be sold to private individuals at some future time when the Government no longer needs them.

Preliminary inspections and housing surveys have been made by the General Service Department of the Emergency Fleet Corporation. Buildings suitable for shipworkers in the vicinity of the yards are to be taken over and put in proper living condition. Transportation by local railway companies to communities having housing accommodations, within easy distance, is being arranged. Where such conditions do not exist houses are to be built upon a standardized plan.

One of the most urgent problems which the English Ministry of Munitions had to solve was the housing of workers in the shipyards and munition factories. Great numbers of wage-earners were collected in factory localities where housing facilities were in many cases altogether lacking. The steps taken by the English Government varied according to local conditions. In some cases loans

were made to public utility societies which undertook the housing of munition workers. In other cases loans were made to individual firms. Three leading types of buildings have been constructed in England for the housing of industrial workers. The three types are, "huts," "hostels," and cottages. The first division includes all buildings of a temporary or semi-temporary character and built mostly of wood. These buildings are much like the barracks of our American cantonments, but consist mostly of smaller units for single families or groups of people up to about one hundred in number. The division included under the name "hostels" includes cottage shells of a permanent character which can later be improved within and converted into good family houses. The hostels are usually built in connected groups of four cottages each. The third class consists of fully completed cottages, usually arranged in groups of four and with about twelve houses to the acre. It is the purpose of the English Government to have these new munition communities remain as permanent villages with local industrial development after the war. Towns have been built up in numerous cases where before was only waste land or thinly populated countryside. Some of these towns are as large as ten miles square. They possess not only ordinary houses and cottages, and the hostels which may later be made into permanent buildings, but also permanent streets, public parks, town halls, school buildings, playgrounds, water, lighting and sewer sites, stores, theaters, and everything needed in a modern community.

The most notable event in the United States Government's dealing with labor during the war has been the collective agreement entered into by the Navy Department, the Emergency Fleet Corporation, and the unions

of the American Federation of Labor, which are involved in the work of ship construction. This agreement provides for (1) union standards of wages, hours, and conditions; (2) a representative board composed in part of the employer and employees interested, to which access is always to be had in the event of disputes arising; (3) a district examiner in each administrative area to act as local agent, investigator, and conciliator for the adjustment board; and (4) an agreement to abide by the decisions of the adjustment board for six months after their promulgation. "This is the most thoroughgoing and satisfactory piece of machinery which the war has brought into the field of American industrial relations."

The American Federation of Labor has established a Lecture Board whose purpose is to arouse the support of labor the country over for the Administration and the successful conduct of the war, an action unexampled in the history of the labor movement in America. This Board, in the words of one of its speakers, "strives to impress on labor the fact that it has everything to gain by Germany's defeat and everything to lose by Germany's victory. . . . The working people must get behind the Government with all their power and influence. I want to impress them with the gravity of the peril. We cannot win by applause, nor by cheers. We must get rid of the Yankee boastfulness. We must discontinue all attempts to discourage the American people in the great task they have undertaken."

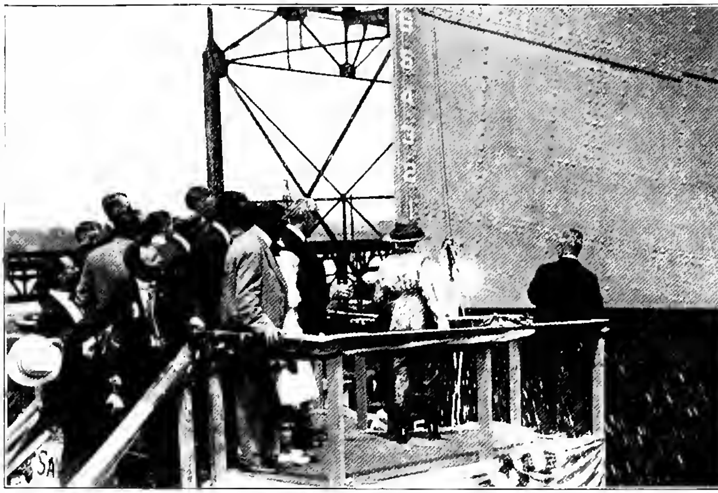
Such are the attitude and spirit of labor, the success of whose efforts are essential in this great crisis of our country. There will be less and less opportunity for enemies to disseminate the seeds of Prussianism and disloyalty in our midst.

Among the various measures taken by the Government to inform the people in all sections of the country upon the needs of the hour, the organization of the "Four-Minute Men" is a striking example. Twenty thousand volunteer speakers, known as the "Four-Minute Men," were enrolled under the direction of the Committee on Public Information, to carry the messages of the United States Government direct to the people. In Boston alone there were sixty members of this notable organization who covered on Wednesday and Thursday nights of each week forty-three vaudeville and moving-picture theaters and addressed in the aggregate audiences of fully eighty thousand people.

The messages delivered did not represent the personal views of the speakers, but were messages prepared in Washington and forwarded to them each week. The language and the form of the speech were left to the speaker's choice, but the substance was under strict orders from the Washington headquarters. A splendid spirit of coöperation was shown not alone by the speakers, but by the owners and managers of the theaters who gave their houses cheerfully and cordially for this purpose.

The Secretary of the Navy, Josephus H. Daniels, at a patriotic mass meeting held on February 22, 1918, in New York, by the American Alliance for Labor and Democracy, spoke as follows:

> The need of the hour is ships. The hammer that strikes a rivet is every whit as effective as the machine gun on the firing line itself. We must build not only ships for the Navy, but ships for the merchant marine. Our soldiers must go across the sea, supplies must go with them, and to those nations fighting side by side with us against the Imperial German Government must we send the food that is absolutely vital to the maintenance of their military strength.



CHRISTENING A STEEL FREIGHTER

DIRECTOR-GENERAL CHARLES M. SCHWAB OF THE UNITED STATES SHIPPING BOARD EMERGENCY FLEET CORPORATION ADDRESSING A GROUP OF MEN IN A SHIPYARD

Every man who fires one shot at the enemy when he might use a machine gun, every man who fails to be on the firing line when the need is sorest, and every man who drives one rivet when he might drive two, is a Benedict Arnold in his heart, and in his soul, for slacking, delaying, and sullen indifference is a treachery that may cost the life of our brothers and our sons.

In the factory where guns are moulded and munitions made, in the shops where clothes are cut and shaped, in the forest where stands the virgin timber for our ships and airplanes — there as well as in France are the battle-fields where the workers of America must prove themselves heroes or stand shamed before the world as traitors.

It is an open secret — I can talk about it freely now — that the real hope of the Prussians that America would never be effective in this war lay in its fatuous belief that labor could be so irritated by insidious propaganda, so misled by hired agitators, as to insure nation-wide strikes, almost upon the declaration of war.

Far bitterer than the failure of the submarine to sweep the seas has been the failure of the German spy to tie this great Republic hand and foot by stampeding labor, organized and unorganized, into something very nearly approaching a social revolution.

Labor will continue its same wise policy, and when this war is over it will have won its own fight as well. No hide-bound capitalist of that type which is rapidly disappearing in this enlightened time, who made the name "capitalist" something of a reproach, will dare then to rise and seriously announce his belief that labor should be suppressed with an iron hand. He will have no standing in the court of last resort — public opinion. For capital and labor are beginning to understand each other and are finding each other not one tithe as bad as they have been painted.

We are getting together, and when we get together and the last mutual misunderstandings and suspicions are cleared away, not all the power of the German army, not all the thunder of the German guns, can shake the triumphant progress of real democracy throughout the whole world.

THE SHIPBUILDING INDUSTRY

In December, 1917, there was formed at Paris, by representatives of the Allies, an Inter-Allied organization for coördinating shipping. The purpose of this organization was to improve the general shipping situation and to expedite American entrance into the war.

France has not had a large merchant marine, compared to that of England. She has not suffered so greatly by the submarine, and has built what ships she could during the war. Her great work has been maintaining a battle front and manufacturing munitions in great quantities.

England, on the other hand, has long been "Mistress of the Seas," foremost in navy and merchant marine. Even preceding the present war British shipyards were worked to full capacity. Ships were built in good times and bad, on a national and business policy of constant expansion. British shipyards took contracts also for other countries. When the war opened, therefore, England was abundantly supplied with ships. Her ships saved the day for the Allies — her Navy keeping the German battleships shut beyond the confines of the North Sea, and her mercantile marine carrying and bringing the endless quantities of food and war materials needed in the great contest. England had then 21,000,000 tons of shipping available. This great volume, with such additional shipping as could be built yearly, made it possible to undergo the ensuing loss by submarines.

During the ten months ending December 29, 1917, the most destructive period of the submarine, there were sunk 667 British ships of 1600 tons and over, and 249 ships under that figure. This makes a total of 916 ships, excluding fishing boats, that must be replaced in ten months, a task which even England could scarcely perform.

In 1913 England built 1,900,000 tons of shipping. The tonnage fell to 688,000 in 1915, and to the low ebb of 538,000 in 1916. It was increased, however, under the submarine menace, to 1,162,474 tons in 1917. Yet sinkings by submarines in 1917 are generally reckoned at 6,000,000 tons, or over five times as much as England produced in the same time, and about three times as much as the 2,064,697 tons produced by both England and the United States in the same time. It is expected, however, that England will increase her output somewhat in 1918, and that the United States will produce at least 4,000,000 tons of shipping in this year. The Emergency Fleet Corporation announced on September 20 that the ship tonnage actually delivered this year amounted at that time to 1,811,000 tons. Launchings totaled 2,596,000 tons, and keels were laid for an additional tonnage of 4,103,000. On the other hand, of course, it is expected that losses by the submarine will steadily decrease. We have, however, an immense and constantly increasing task of transportation. England cannot supply our ships. Japan is building a few ships, and will do more as she can secure steel. Other countries are doing little in shipbuilding. For the present, at least, the increase of the shipping world depends upon our own American shipbuilders. In the words of the British Prime Minister in Parliament, on December 14, 1917, "Victory is now a question of tonnage, and tonnage is victory." American shipyards must supply the balance of power to overthrow the common enemy.

At present we have under way more than double the amount of ships now under construction in Great Britain, for centuries the greatest shipbuilding country in the world. We are building fifteen times the tonnage we

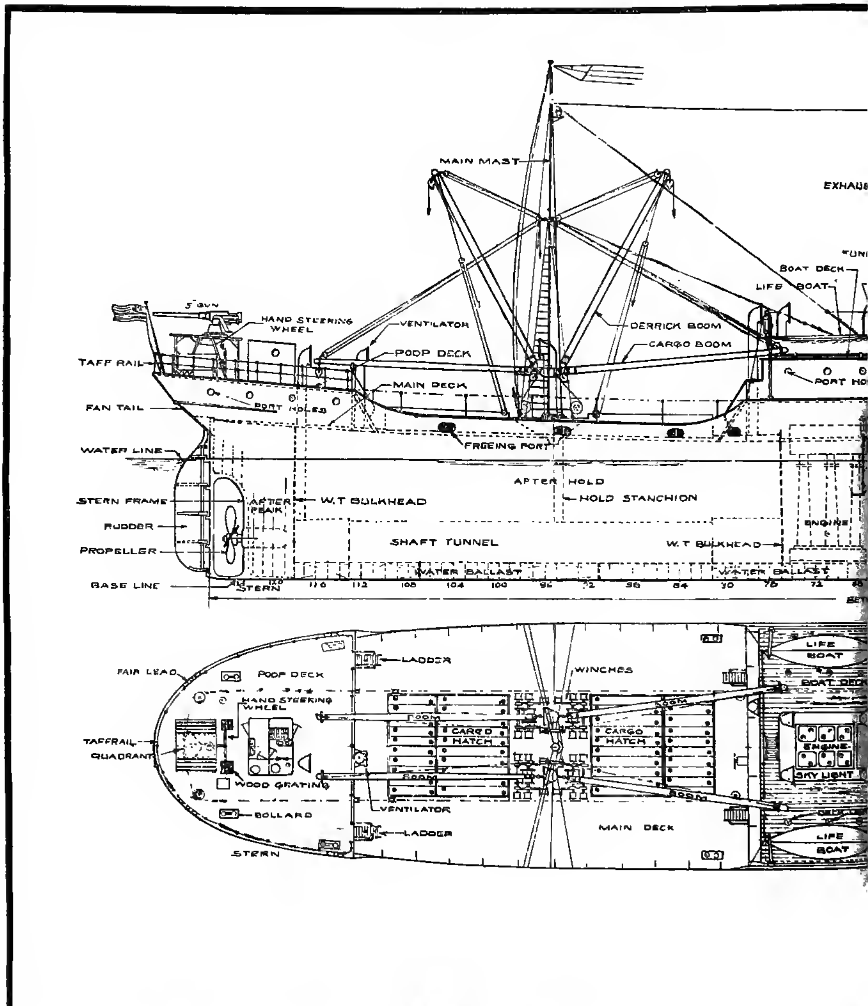
formerly averaged. To double any established industry in normal times would be a feat. What a record, then, in eighteen months to multiply by fifteen a long neglected industry, while also fitting out an army, manufacturing guns and aeroplanes, and supplying food and munitions to the Allies!

There will be increased employment for many years in shipbuilding after the war is over. Indeed, the contracts now in force extend over a considerable period of time, and new contracts will be let by this country both during and after the war. After the war, also, other countries are likely to have ships built in American yards because of the excellence of the American-built vessel. The American industry will be placed upon a permanent basis.

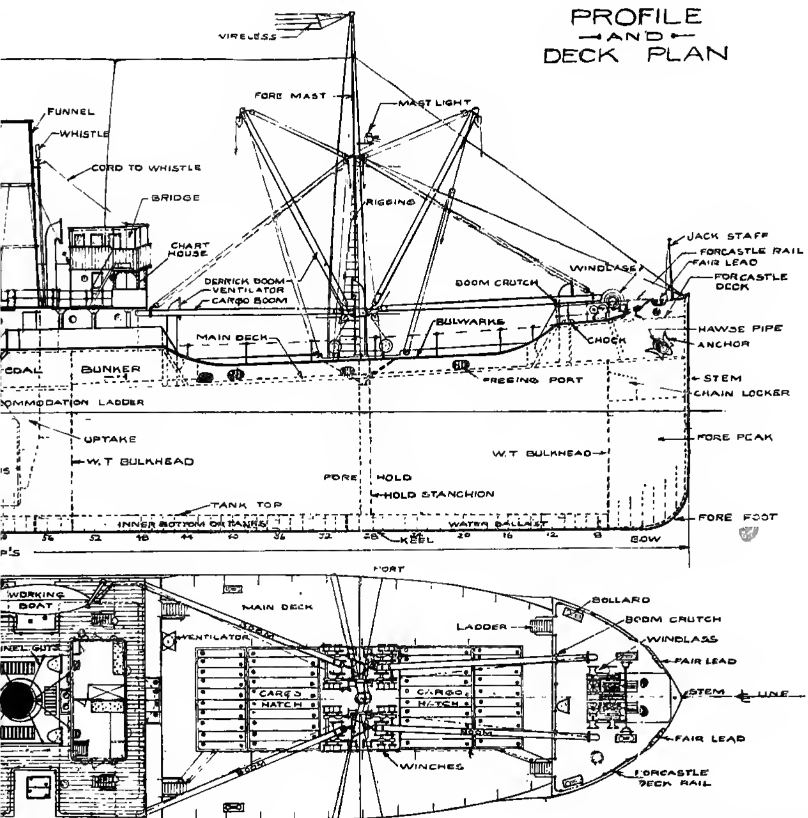
War contracts for munitions and other supplies made by foreign governments with the manufacturers of this country are so extensive that it will take a number of years to fill them, eight or ten years, probably, in some cases. Post-war traffic in war materials must, therefore, be provided for.

Moreover, the balances of trade must be readjusted in the commerce of the world. Before the war the United States sold shoes in ninety-six foreign countries. This business, with that of ten thousand other exports and imports, decreased or checked altogether by the great conflict, must be rebuilt and enlarged. This will demand the largest fleets of merchant vessels that the world has yet seen.

The Civil War made this country not only one politically for all time, but one commercially, one in the common interests of every-day life. Interstate and sectional barriers were broken down. Travel and trade were increased a thousandfold. The railroad, the newspaper, the



MAIN MAST
EXHAUST
BOAT DECK
LIFE BOAT
5" GUN
HAND STEERING WHEEL
VENTILATOR
POOP DECK
DERRICK BOOM
CARGO BOOM
TAFF RAIL
MAIN DECK
PORT HOLES
FAN TAIL
PORT HOLES
FREEING PORT
WATER LINE
AFTER HOLD
STERN FRAME
AFTER PEAK
W.T BULKHEAD
HOLD STANCHION
RUDDER
ENGINE
SHAFT TUNNEL
W.T BULKHEAD
PROPELLER
WATER BALLAST
WATER BALLAST
BASE LINE
STERN
FAIR LEAD
POOP DECK
LADDER
WINCHES
LIFE BOAT
BOAT DECK
HAND STEERING WHEEL
BOOM
CARGO HATCH
CARGO HATCH
TAFFRAIL
QUADRANT
ENGINE SKY LIGHT
WOOD GRATING
BOOM
BOOM
BOLLARD
VENTILATOR
MAIN DECK
LADDER
LIFE BOAT
STERN



BY COURTESY OF
WILLIAM DOUGAL
STAFF INSTRUCTOR

DRAWN BY
JOSEPH E. GAGNON

U.S.S.B. – E.F.C.
EDUCATION AND TRAINING SECTION
BLUE PRINT READING
FOR
STEEL SHIP CONSTRUCTION
SUPPLEMENTARY TRAINING
COURSE 2-S DRAWING # 2

telegraph, the telephone, public education, modern business, all are practically developments of the post-war period, the last fifty years. So now, international barriers are being broken down; international interests, political, commercial, and cultural, are becoming recognized; the interdependence and essential unity of the races of the modern world are becoming more and more evident. The highways of the seas will be traversed as never before. There shall be a place in the sun for every nation that seeks it by peaceful means.

It is most interesting and encouraging to present here the accomplishment of our Army and Navy in transportation during the first year of our participation in the war. Our great national holiday, the Fourth of July, was made especially a day of rejoicing this year by the publication in the press throughout the country on the morning of July 3 of the number of men sent to France since the first ship sailed with military personnel. The President's statement, including a letter of information from the Secretary of War to him, and his reply, follows:

> I have to-day received the following letter from the Secretary of War which seems to me to contain information which will be so satisfactory to the country that its publication will be welcomed and will give additional zest to our national celebration of the Fourth of July:

War Department
Washington, July 1, 1918

My dear Mr. President:

More than one million American soldiers have sailed from the ports in this country to participate in the war in France. In reporting this fact to you, I feel that you will be interested in a few data showing the progress of our overseas military effort.

The first ship carrying military personnel sailed May 8, 1917, having on board Base Hospital No. 4 and members of the Reserve Nurses' Corps.

General Pershing and his staff sailed on May 20, 1917. The embarkations in the months from May, 1917, to and including June, 1918, are as follows:

1917 — May, 1718; June, 12,261; July, 12,988; August, 18,323; September, 32,523; October, 38,259; November, 23,016; December, 48,840.

1918 — January, 46,776; February, 48,027; March, 83,811; April, 117,212; May, 244,234; June, 276,372.

Marines, 14,644.

Aggregating 1,019,115.

The total number of troops returned from abroad, lost at sea, and casualties is 8165, and of these, by reason of the superbly efficient protection which the Navy has given our transport system, only 291 have been lost at sea.

The supplies and equipment in France for all troops sent is by our latest reports adequate, and the output of our war industries in this country is showing marked improvement in practically all lines of necessary equipment and supply.

Respectfully yours

NEWTON D. BAKER

To which I replied:

The White House
Washington, July 2, 1918

MY DEAR MR. SECRETARY.

Your letter of July first contains a very significant piece of news and equally significant report of the forwarding of troops during the past year to the other side of the water. It is a record which I think must cause universal satisfaction, because the heart of the country is unquestionably in this war and the people of the United States rejoice to see their force put faster and faster into the great struggle which is destined to redeem the world.

Cordially and sincerely yours

WOODROW WILSON

The accelerated troop movement to France has been designed to meet the emergency created by the German effort to achieve victory before America's man power could exert its full force. How long the present rate of transportation will be maintained depends upon developments in France and the length of time the surplus ship tonnage furnished by Great Britain can be employed for this work. In this connection, Secretary Baker has said that he disapproved of speculation as to the future records in troop movements, declaring that he did not desire to have "past performances made the basis of speculation for the future."

We may be sure at least that the enlarged American military programme calls for an army of nearly 5,000,000 men by July, 1919. General March in considering the new $7,000,000,000 army estimate before the House Appropriations Committee on September 19, 1918, stated that there were already 3,200,000 men under arms. It was planned at that time to call an additional 1,700,000 men into the service in the course of the next nine months. The achievements already recorded to the credit of the Navy and the Shipping Board, together with the plans for the coming months, leave little doubt as to our ability to land these men in Europe and keep them effectively supplied with war necessities.

Chairman Hurley of the Shipping Board conceived the idea of celebrating the one hundred and forty-second birthday of the Republic, July 4, 1918, by making it the greatest day in the world's history of shipbuilding. Mr. Hurley called upon the shipyards of the Nation and every yard in which a ship could possibly be completed responded to the patriotic appeal. In round numbers one hundred ships were launched on this eventful day in American yards.

Historic telegrams passed between Chairman Hurley and General Pershing while preparations were being made for these launchings.

Chairman Hurley's message to the army in France said:

Not by delaying a single ship, but by speeding to the utmost, the American shipyards will launch nearly one hundred ships on July 4. On this one day, celebrating the Nation's independence and backing up the boys in the trenches, the men in the shipyards will launch 450,000 deadweight tons, as much as was launched in six months last year.

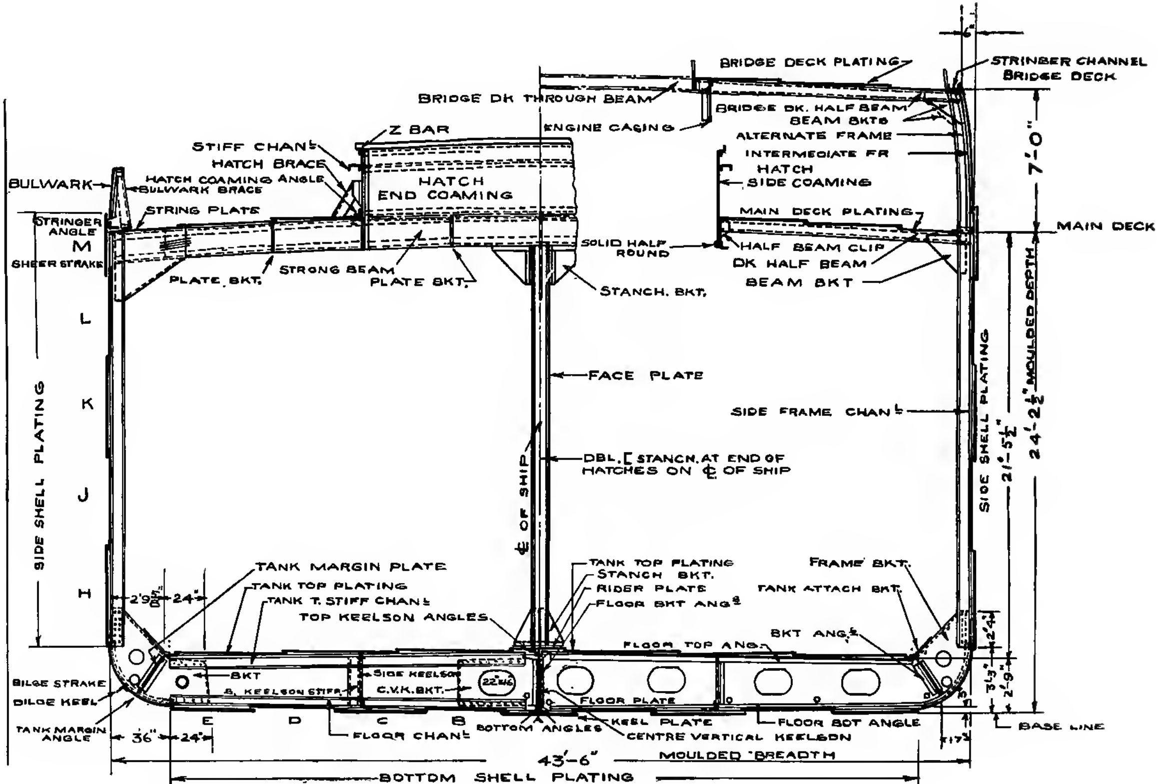
Your inspiring leadership of the American army in France has thrilled the shipyard workers, and if the time comes when you need even the shipyard men over there, they will go to the last man. We want you and the boys in the trenches to know that the men in the yards are going the limit to provide in record-breaking time the ships that will carry more men, food, and munitions to the intrepid American expeditionary forces.

General Pershing replied as follows:

The launching of one hundred ships on the Fourth of July is the most inspiring news that has come to us. All ranks of the army in France send their congratulations and heartfelt thanks to their patriotic brothers in the shipyards at home. No more defiant answer could be given to the enemy's challenge. With such backing we cannot fail to win. All hail, American shipbuilders.

Under the title "They have Come for the Sake of France," Mr. Hawthorne Daniel gave in "The World's Work" for December, 1917, a beautiful picture of an early arrival of American troops in our sister Republic. His words suggest in most fitting terms the reasons which underlie this vast national enterprise of building ships. The article reads in part as follows:

An automobile was waiting at the door when the signalman brought us word that a convoy had anchored ten miles down



MIDSHIP SECTION OF A STEEL FREIGHTER OR CARGO BOAT

A cross section of the ship at its widest and deepest part, showing construction of the hull, floors, frames, hatches, hold stanchion, and decks

the river to wait for the turn of the tide. Fortunately we were not busy, and consequently were able to ride down to —— in order to be among the first to welcome the arriving soldiers.

It was a matter of minutes to be bowling along the strip of white road, through the American army camp, deserted now, but soon to be filled to overflowing, across a railroad, past a siding filled with strange little freight cars, between two rows of beautiful old poplars, on our way to a point from which we could see the ships as they passed. Two airplanes soared overhead on their way back to the aviation field after sweeping the river mouth for possible German mines. Children waved to us as we passed, shouting *Américains!* as they recognized our nationality.

We turned off the main road before reaching —— and rolled down a pretty little lane, that ended near a villa at the water's edge. Already the ships had started again. We could hear the rattle of their windlasses as they heaved in their anchors. One by one they slipped up the channel, passing near us as they made a turn that brought them close to shore. The beach was dotted with delightful French people. On the low wall of a garden that sloped down from the villa near which we had stopped, a French girl was standing. She was, perhaps, sixteen, and she held an American flag that waved over her head and threatened to lift her from the wall as the breeze caught its brilliant folds. A ship passed close in, and she waved the flag with all her strength. On the crowded deck of the transport the troops waved in return. Another ship passed, and again she waved the flag. Again the crowded decks answered. And then, steaming sedately up the channel, came one of the former German liners, once named for a member of the royal house of Hohenzollern. Its decks were crowded with three thousand men. The rigging was filled with them. The rails were lined. Every inch of the ship's enormous length seemed alive with men in khaki and sailors in blue.

The girl on the wall seized her flag with renewed vigor, and waved it madly. We expected to see the same answer the other ships had given, but instead, as I trained my glasses on the bridge, I saw an officer seize a megaphone. The gold on his

sleeve glistened in the sun as he spoke to the men below him. The distance was too great for us to hear his words, but a moment later the ship seemed swayed by a common impulse. Every hat waved in the air for an instant, waved again — and again. Then over the glistening water came three mighty cheers.

The girl stood amazed. For a moment she failed to grasp it all, and finally it dawned on her that they had returned her greeting — that the spirit of America had answered that of France. She seized her flag, and waved it until it snapped in the breeze. Then, overcome by her emotions, she jumped from the wall, and threw her arms about the neck of a little woman in black who was standing there.

"*Chère mère,*" she cried, "*ils sont venus pour la France.*" (Darling mother, they have come for the sake of France.)

Yes, for the sake of France, Great Britain, Belgium, Italy, Russia, Greece, Serbia, and Roumania! Yes, for the liberty, equality, and fraternity of all peoples! Yes, even to save Germany from her own doom!

THE SHIPBUILDERS

M. A. DeWOLFE HOWE in the "Boston Herald"

They that go down to the sea in ships,
  They shall bring peace at last —
Peace through food for the hungering lips,
  Peace through the far-sent armies vast:
They that go down to the sea in ships,
  They shall bring peace at last!

But the ships to bear them over the sea,
  Ships enough and to spare
For the death-sown track where the snipers be,
  The vipers that kill in the darkness there —
Where are the ships that shall sail to free
  The world from its blood-red care?

THE SHIPBUILDERS

As the statue hid in the stone they stand
  Deep-hid in the oak and steel,
Waiting for craftsmen of cunning hand
  To fashion them, rib and keel,
Till the myriad builders, band on band,
  Shall the land-locked fleet unseal.

So arm ye, who may not bleed in France,
  With tongs and hammers and saws:
These be your weapons — aye, these your lance
  To break in the holy cause!
For they that go down to the sea in ships,
  With food for the gasping, hungering lips,
With armies that cry for a squadron vast,
  These, these shall bring peace at last!

CHAPTER II

REVIVING A NEGLECTED INDUSTRY

SHIPBUILDING is the oldest American industry. During colonial days it was necessary to carry on trade with Europe in articles of merchandise which could not be produced in the new country. In addition to the demand for ships created by this trans-Atlantic commerce, there was some trading among the colonies, and many of the settlers engaged in fishing. From the very first the colonists built boats and small ships, of about thirty or forty tons, of the "pinnace" type. For many years these little craft made regular trips across the Atlantic. Indeed the historic Mayflower registered only one hundred and eighty tons.

The following statements give some of the outstanding occurrences of interest in the development of this industry in America during the two hundred and fifty years from the founding of the colony at Jamestown to the outbreak of the Civil War:

In 1607, before the coming of the Mayflower, the Virginia, of thirty tons, was built on the coast of Maine. This vessel crossed the Atlantic many times.

In 1614 the Onrust, the first vessel launched in the Middle Colonies, was built on Manhattan Island by Adrian Block.

In 1631 The Blessing of the Bay, of thirty tons, was built by Governor John Winthrop in Charlestown, Massachusetts. This vessel was used for many years in trade with Virginia.

In 1635 Richard Hollingsworth, a name long associated with the American industry, built the first sizable ship launched from American ways, one of 300 tons.

In 1643 William Stevens launched a vessel of 500 tons at Gloucester, Massachusetts.

In 1651 a shipyard was established at Newburyport, Massachusetts.

Following these years many new yards were opened and builders constantly increased in number.

In 1714 the first "schooner" was launched at Cape Ann, and this name was then first used.

In 1730 twenty-five deep-sea whalers sailed from Nantucket alone.

During the year 1772 the American colonies built a total of one hundred and eighty-two ships.

In 1781 John Paul Jones built the first ship of the American Navy at Portsmouth, New Hampshire.

In 1791 Alexander Hamilton, Secretary of the Treasury, reported an American merchant marine of 476,274 tons.

In 1800 our yards built 995 vessels, with a tonnage of 106,000.

On August 7, 1807, Fulton's Clermont steamed up the Hudson River.

In 1838 more than 700 steamships were built in the United States.

In 1843 ~~Harlan and Hollingsworth~~ built the first iron ship in America. See p 61 (Betts & Pusey)

In 1849 the discovery of gold in California sent American ships around Cape Horn in great numbers and stimulated shipbuilding.

In 1855 the high point of American shipbuilding from the beginning to the present war was reached. The total launchings amounted to 2027 ships.

Thus it is seen that American shipbuilding increased steadily to the period of the Civil War, when it fell into a decline which continued until the outbreak of the European War, and the demand arose for a revival of an American merchant marine. In 1856 ninety per cent of our foreign commerce was carried in American bottoms; in 1913, only eleven and four tenths per cent was so carried.

The wars of the Revolution and of 1812 naturally stimulated ship construction, and American ships became the fleetest and the finest in the world. Speed was a requisite for vessels that must often flee from pirates, revenue cutters, and hostile cruisers on the high seas. Trade with many countries opened and the United States took its place as a world power with a merchant fleet second only to that of England. The Civil War, however, engaged the activities and resources of the country in an internal contest. Attention was withdrawn from sea traffic. Foreign commerce was neglected. The mercantile marine languished. One of the chief causes of this decline, however, was the inability of shipbuilders in this country to construct iron vessels, at a time when England, with her resources in iron and mechanical genius, was turning rapidly to iron construction. As late as 1904 fifty-eight per cent of American vessels were of wood, while in 1860 thirty per cent of British vessels were of iron, and but few wooden ones have been launched in England since that time.

The great extension of the railroad lines in this country following the Civil War period reduced the number of vessels in coastwise trade and in commerce on the Great Lakes and on the Mississippi River. From the early seventies such commerce rapidly declined.

A contributory cause of the decrease in our shipbuilding was the increasing difficulty after the Civil War for American labor in competing with foreign labor, working in foreign yards. In Norway shipworkers could be hired for $3.50 a month, and in other European countries shipworkers were paid less than in America. Furthermore, in the reconstruction of the United States the prices of commodities and wages long felt the effect of the war period. Many new industries, also, of which shoe manufacture is a conspicuous example, were established and workers were demanded for them in increasing numbers. Factory employment displaced many earlier forms of employment and attracted workers from many others. Shipbuilding was affected by all these conditions. The builder of American bottoms could neither pay the wages earned by American labor in ordinary occupations nor otherwise meet the competition of foreign-built shipping.

In the earlier years of our history, practically to the time of which we are speaking, many of the youth of the country were attracted to a seafaring career. This was especially true along the coasts and in the neighborhood of maritime centers. At home opportunities for careers were limited mainly to a few lines, such as agriculture, store-keeping, and the more common professions. There were then few mechanical industries to employ people. Young men went to sea for occupation, for adventure, or as a means of finishing an education by travel and by seeing life in foreign ports. Richard H. Dana's classic, "Two Years before the Mast," is a revelation of this period of American history. There were numerous commercial houses maintained in foreign ports by American merchants, from Revolutionary times down through the

last century. These trading posts employed many Americans and kept open the avenues of ocean commerce.

After the Civil War careers were offered in many lines at home. The sea no longer called to great numbers of boys and men. The central part of the country was developed, the great West was opened up, and American business and industry presented careers never before known in world history. The Nation became vast and rich and powerful, and busy in fostering internal expansion.

Some interesting sidelights are thrown upon the period of development of American shipping which we have just been reviewing by the following quotation from "Old Shipping Days in Boston," a pamphlet issued in 1918 by the State Street Trust Company, Boston:

> In the year 1770 it is figured that Massachusetts built one half of all the ships constructed in America. It may also be of interest to note that on one day, October 27, in the year 1791, seventy vessels sailed from Boston for different parts of the world. A sketch in the Massachusetts Historical Society collections at about this time reads: "There are 80 wharves and quays, chiefly on the E. side of the town. Of these the most distinguished is Boston Pier, on the Long Wharf, which extends from the bottom of State Street 1743 ft. into the harbor. Here the principal navigation of the town is carried on; vessels of all burdens load and unload; and the London ships generally discharge their cargoes. . . . The harbor of Boston is at this date crowded with vessels. It is reckoned that not less than 450 sails of ships, brigs, schooners, sloops, and smaller craft are now in this port. . . . "

It only requires a little imagination to go back to the early days when most of the farmhouses were near the sea and in front of each usually could be seen riding at anchor a trim little vessel, in which the owner went fishing during the week and in which the whole family went to church when Sunday

came round. These sturdy New Englanders have often been referred to with much truth as half farmer and half sailor. . . .

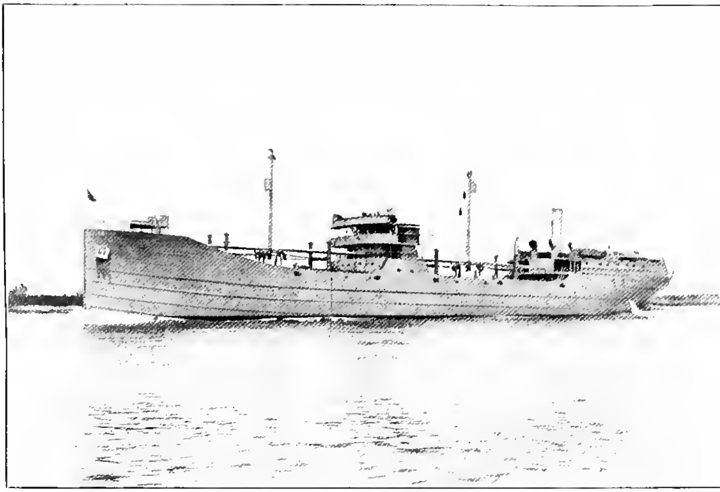
During the wild race for gold in California in 1849 seven hundred and seventy-five vessels cleared from Atlantic ports for San Francisco. Massachusetts sent two hundred and twenty-four of this number. Ninety-one thousand four hundred and five passengers from almost every nation on the globe arrived in the Golden City during that year, whereas the previous year only four vessels arrived from Atlantic ports. Officers and crews rushed ashore in search of the gold, leaving their ships to take care of themselves, and the result was that many vessels never again left the harbor of San Francisco, being transformed into store ships, hotels, hospitals, and even prisons. Many were actually left there to decay. One full-rigged ship which was run ashore was made into a "bunk-house" as the Westerners called it, a door being then cut in her side, with a painted hotel sign over it. Another vessel was utilized as a saloon, and still another, the Euphemia, became the first prison in San Francisco. A rather curious thing happened to the Niantic; she was beached and turned into a warehouse, gradually becoming embedded in mud at some distance from the shore. In her new rôle she made large sums of money for her owner. A fire, however, burned her topsides, but the rest of her hull was utilized as the cellar of the Niantic hotel, which was the only really dry cellar in the neighborhood. Some time later the building was torn down, and thirty-five baskets of champagne were found hidden between the floor timbers, having been there for over twenty-one years. This wine was very choice, and some of the "forty-niners" celebrated their arrival there many years before by opening a bottle.

At the height of the gold fever every shipyard on the coast set to work to build ships, even the farmers becoming wood-sawyers, and every one who worked on a vessel was allowed a share in the venture. An ordinary seaman commanded wages of $150 per month or even more, and there was a yarn that went around among seamen that during these times a captain had to produce satisfactory recommendations from his last crew before a new one would ship with him. At one time freight

rates were $60 per ton of forty cubic feet, some vessels netting as much as $72,000 on one voyage out. Beef and flour brought $50 a barrel, and miners were paid from $100 to $1000 a day for washing dirt.

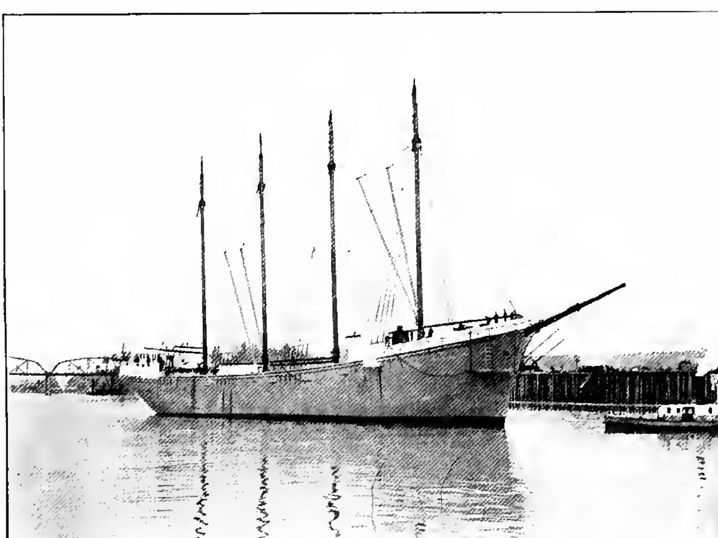
The American navigation policy was such in the early years as to encourage the merchant marine. It began with a treaty of commerce entered into with France in the year 1778, which had a provision to take as the "basis of their agreement the most perfect equality and reciprocity." Congress later passed acts levying tonnage dues and import taxes so as to give American ships a practical monopoly of American commerce. Coastwise trade was closed to foreign shipping. Foreign-built or foreign-owned vessels were forbidden American registration and the use of the American flag, or repair in American ports, except under the most restrictive regulations. These regulations continued practically unchanged for three quarters of the nineteenth century. Then the changed commercial and economic conditions of the country and of the world, and the desire to increase our shipping by all possible means led to a modification of these statutory restrictions. By an Act of Congress in 1892 foreign-built vessels of eight thousand tons burden and a speed of twenty knots an hour, which are owned in certain part by Americans can fly the American flag. This act was an attempt to increase our tonnage, which was rapidly decreasing through the inactivity of American shipbuilders, by the addition of foreign-built ships, and it was an important step toward reciprocity in world commerce.

Certain Government regulations have been especially discouraging to American shipowners. Our laws have forced them to measure tonnage on a larger basis than is used in other countries, thus entailing higher tonnage



A TRIUMPH OF ORGANIZED PRODUCTION

The S.S. Tuckahoe, a 5500-ton fabricated steel collier built in 27 days at Camden, N. J., by the New York Shipbuilding Corporation. On the fortieth day from the laying of the keel, she put to sea with a full cargo on board



A MOTOR-DRIVEN WOODEN FREIGHTER LAUNCHED BY THE PENINSULA SHIPBUILDING COMPANY AT PORTLAND, OREGON

charges when in foreign ports. Pilotage, repairing, and wharfage cost more for the same reason. Our inspection laws are stricter, our ships must employ more men in the engine-room, and our wage scale is higher than in other countries. To meet American conditions and American standards it is estimated that it has cost American shipowners $40,780 more each year to sail an average merchant ship than it has cost their overseas competitors.

On this subject Mr. Eugene P. Thomas has written as follows, in "Marine Engineering" for December, 1917:

> Our country has had to pay dearly for our abject submission to the decay of our merchant shipping in foreign trade. But the lesson has been learned, and with it has come the recognition of these fundamental principles: We must be enabled to freight our products to foreign markets at a cost not exceeding that which will be available to our competitors, and this will be possible only if we have an American merchant marine unhampered by restrictions from which our chief competitors are free. The British shipping industry, which for generations has been, and is still, by far the greatest in the world, was built up by the exertions of the men engaged in it. It prospered because it was free from restrictions to which its competitors were subject.

Shortly after the outbreak of the European war the United States awoke to the serious need of increased naval preparedness, and legislation was begun in Congress to determine the ways and means of best meeting the situation. At the same time it became apparent that the war was offering unprecedented opportunities for increasing our world commerce. Where the merchant fleets of the warring nations were withdrawn from general trade, our merchant ships might serve not only our own needs, but the needs of the European countries. The National City Bank of New York opened its branches in

Latin America, inaugurating an era of increased commerce between North and South America. Following this action by the National City Bank, a number of foreign trade corporations have been organized with the same purpose, of securing foreign trade. The American International Corporation, organized in November, 1915, and having excellent financial backing, was established to stimulate engineering enterprises in foreign countries, which were expected to create an extensive market for our engineering products. Such movements, fostered and maintained by the most capable financiers and approved by the best statesmen, enlisted capital in a great campaign for foreign trade. Congress took action, and voted $50,000,000 for ship subsidy and purchase. Shipbuilding was revived and new shipbuilding plants were projected, as we have already shown in the preceding chapter.

At the same time greatly increased prosperity began to be felt in the industries which contributed to shipbuilding — iron and steel manufacture, lumbering, the machine trades, automobile construction, and various other related lines of manufacture. Thousands of workers thrown out of employment by temporary industrial conditions found employment in the shipyards. Shipyard communities grew up — towns and small cities — where formerly were waste land and inactivity. Coastwise ports, where vessels of commerce congregate, loading and discharging, entered upon a new era of prosperity. An activity excelling that of the early days appeared everywhere under the mighty stimulus of the new revival of merchant shipping.

A statement made by a high official of one of the great steamship companies, early in 1916, shows the importance and far-reaching influence of our present programme for a merchant fleet. This statement is as follows:

THE DEMAND FOR A REVIVAL

The establishment of an American merchant marine presents to the laborer increased opportunity for regular and steady employment; to the merchant enlarged markets in which to trade; to the capitalist and small investor increased opportunity for the employment of capital in legitimate enterprises; and to all the broadening of opportunities and the gradual upbuilding of commerce. The prime reason why the United States should have a larger merchant marine is stated in a nutshell, in that to-day only nine and one half per cent of our ocean commerce is being carried under our flag, while one hundred years ago ninety-one per cent was so transported.

Aside from any war necessity there is an insistent and growing demand for increasing our foreign commerce. Mr. Robert Dollar, in an article entitled "The American Merchant Marine" in the "Scientific American" of April 7, 1917, speaks thus:

The clamor for an American merchant marine is not an idle vaporing. This country has reached a point where it must have foreign trade, and plenty of it. There was a time, when we were developing our country, when we did not require foreign trade to any great extent. But that time is past. Our Secretary of Commerce tells us that with all our factories running full time, we can manufacture in six months all that we require for a year's domestic consumption. Therefore we must choose between exporting half our manufactured products, or running our industries half time. In fact, there is not a single one of us, however indifferent he may feel toward foreign trade, who would not find, on close analysis, that he really was interested. The farmer produces more than he can sell locally; throughout the country, he produces more of many crops than America can eat. The manufacturer is in the same boat. So for farmer and factory worker alike it is essential that we export surplus production to foreign shores. The financial world is interested in underwriting this business; the transportation world, in making the movement possible.

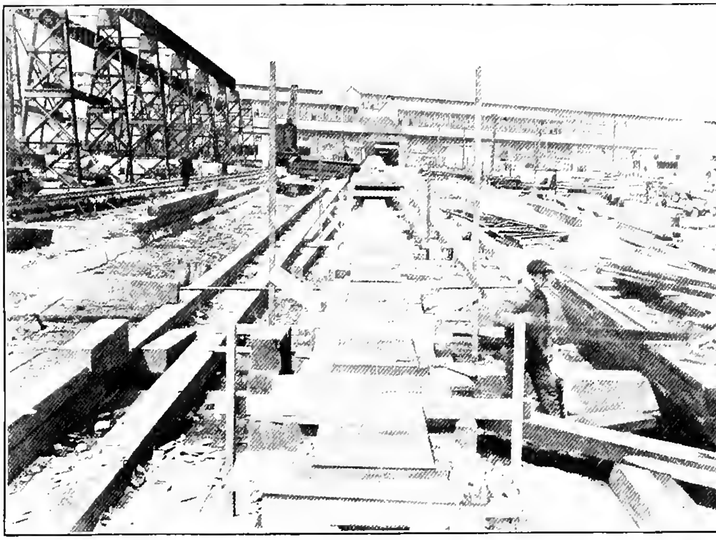
It is not merely a question of whether we shall carry on a definite volume of foreign trade in our own ships or in ships

belonging to somebody else. Even from this point of view there is much to say for an American merchant marine; but there is a much larger point of view. Every ship that takes a cargo out from its home port must either seek a return cargo or come home in ballast. The latter procedure, of course, involves a double charge against the cargo taken out; so every effort is made to find some sort of cargo to bring back. There is no more efficient trading scout than a fleet of boats in foreign ports, looking for something to bring home. Trade is, as nearly as possible, an exchange of commodities; and here we should have a tremendous impulse toward stimulating trade.

The shipbuilding centers of the country are as follows:

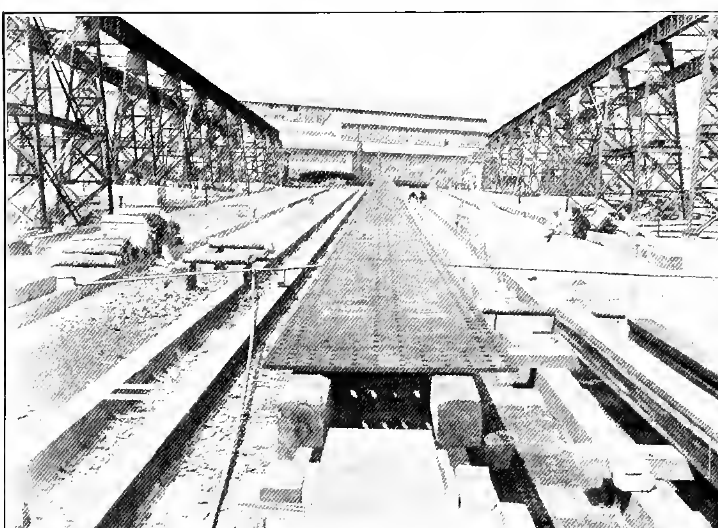
1. The Atlantic Coast, where shipyards and navy yards have long been established.
2. The Gulf Coast and Mississippi Valley.
3. The Pacific Coast.
4. The Great Lake Region.
5. The inland centers, where parts of ships are fabricated and whence they are taken to the coast or Lake yards for erection, launching, and completion.

As a means of speeding up shipbuilding operations, the Emergency Fleet Corporation first divided the country into six shipbuilding zones with a competent director of construction in charge of each. There were two zones on the Atlantic Coast, north and south, and two on the Pacific, northern and southern; one zone for the Gulf Region and one for the Lakes. While this plan resulted in decentralization of shipbuilding work in a degree, it magnified the importance of work in each zone and hastened its accomplishment. The most capable shipbuilders of the country have been called to act as directors of construction in the six zones, and Mr. Charles M. Schwab, Chairman of the Bethlehem Steel Corporation, has been made Director-General of America's shipbuilding.



THE FIRST STAGE IN THE CONSTRUCTION OF A FABRICATED SHIP

The keel blocks are lined up in the center and the fixed ways are shown on either side



AFTER THE KEEL PLATES HAVE BEEN LAID

Shipyards old and new are found scattered all along the coast from Maine to Florida. The State of Maine has long been famous for its wooden shipyards, which are found at Thomaston, Bath, Freeport, and Biddeford. New Hampshire has two well-known shipyards at Portsmouth. The Massachusetts yards center in Massachusetts Bay at Boston, Quincy, and Squantum. Connecticut has yards at Groton, Gildersleeve, and Stratford, and the Atlantic Coast submarine base at New London. Many large yards are found in and around New York City and on the New Jersey coast, one of the largest being the Submarine Boat Corporation at Newark. The largest on the coast is the Hog Island Shipyard at Philadelphia. Another is found at Bristol, Pennsylvania. Numerous other yards, many of them building wooden ships, are scattered along the southern coast — at Wilmington, Delaware; Baltimore and Sharptown, Maryland; Newport News, Norfolk, and West Point, Virginia; Wilmington, North Carolina; Charleston, South Carolina; Savannah, Georgia; and Jacksonville, Florida.

At the present time construction work is under way for the largest ship terminal in the world at the port of Boston, the leading shipbuilding center of colonial times. The National Government has purchased from the State of Massachusetts, as an embarkation site for troops and supplies, 2,500,000 feet of land and flats running the entire length of the reserved channel in South Boston. The price paid for this land was about $1,330,000. At least $16,000,000 will be spent for dredging the channel and its approaches and for docks, buildings, and tracks for the terminal, while from $3,000,000 to $5,000,000 additional will be expended for equipment.

New York is the leading Atlantic port at the present

time; upon the completion of its new terminal, Boston will rank very high.

While the density of population of the Southern States has never equaled that of the Northern States, from the earliest times in American history there has been considerable mercantile activity on the great inland sea of the Gulf of Mexico. Through the colonial period shipyards were established here and turned out many sailing craft for coastwise traffic and for trade between the colonies, the West Indies, and European ports.

The leading yards of this region are now located at Tampa and Pensacola, Florida; Mobile, Alabama; Moss Point, Mississippi; New Orleans, Louisiana; and Beeville, Beaumont, Orange, Harrisburg, Houston, and Rockport, Texas.

In colonial times Rhode Island was prominent in shipbuilding along with the other North Atlantic Colonies. General Nathanael Greene, "the Rhode Island Blacksmith," worked in an anchor factory in Rhode Island. Her ships, indeed, vied with those of Massachusetts in seeking world trade. It was Massachusetts and Rhode Island merchants and shipowners who first established American commercial houses in China and took the lead in Oriental trade. The Rhode Island shipbuilders, from their activity and interest in shipbuilding, caused the extension of shipbuilding into the trans-Alleghany country, to the tributaries of the Mississippi River. They became especially active on the Ohio River. Many of them migrated to the new land and became pioneers of the new industry there. Early in the Revolution the Ohio towns began trading up and down the Ohio and the Mississippi, using ships, great barges, and flatboats. The flatboats of this region are famous to the present day.

The great shipbuilding era of this rich and extensive region followed the year 1800. Its activity gradually lessened in the years immediately preceding the Civil War and came almost to a complete standstill following the war, or more exactly about the year 1870. An idea of the river traffic in the early days may be gained by a glimpse of the cargo statements of the time. In March, April, and May in the year 1800, there passed Fort Massac, as parts of cargoes for the Southland, 22,714 barrels of flour, 12,500 barrels of pork, 18,710 barrels of bacon, 75,814 pounds of cordage, 3650 yards of linen, 700 barrels of potatoes, and great quantities of other natural products of the region. Such a volume of traffic served as the greatest stimulus to shipbuilding, especially of ocean-going craft, as well as of flatboats and barges. Here was timber in abundance, great forests of black walnut, durable, strong, and light. Walnut was used for the ship frame, and oak for its planking. Iron works were opened at Pittsburgh. Hemp grew abundantly in this locality and cordage factories, or "rope walks," were established at Pittsburgh, Marietta, and Cincinnati.

In the year 1800 the first two full-rigged ships were built on what was then considered western waters, the St. Clair, of 110 tons, at Marietta, Ohio, and the Monongahela Farmer, of 250 tons, at Elizabeth, Pennsylvania. At Cincinnati the sight of the St. Clair, the first completely ocean-rigged vessel seen there, aroused as much interest and enthusiasm among the people as did the coming of the first steamboat ten years later. "She is bound for some of the West Indie Islands," wrote an eyewitness. "On her arrival the banks were crowded with people, all eager to view this pleasing presage of the future

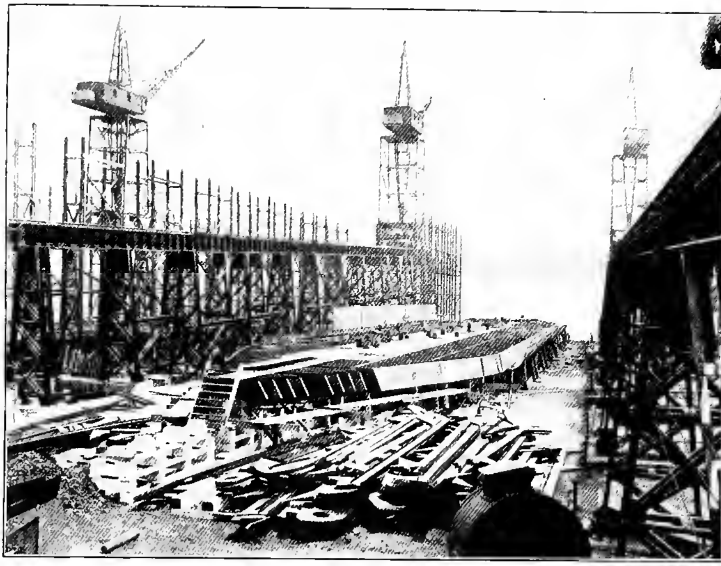
greatness of our infant country. This is the first vessel which has descended the Ohio equipped for sea." This ship carried a cargo of 750 barrels of flour, which her commander, Commodore Abraham Whipple, sold in Havana for $40 a barrel. Later she carried cotton to Liverpool and entered into general ocean travel.

Immediately the shipyards of the Ohio produced many other similar vessels, having an average capacity of about 150 tons and drawing as little water as possible so that they might pass safely over the river shoals. Those built at New Orleans at the same time had about 135 tons capacity. The Spanish ships which sailed in this part of the world in the same years averaged less than 100 tons, and the British ships sailing here were still smaller. Most of the vessels built in the early century in the Gulf and Mississippi Basin were engaged in coastwise and West India trade.

In the year 1804 the Louisiana, of 300 tons, the first large ship of the region, was launched at Pittsburgh. Later, when passing from the Gulf of Mexico into the Atlantic, this ship had to change its river-sailing crew for an ocean-going crew. Great prosperity in ship construction and in river and ocean traffic prevailed in this extensive inland region until Jefferson's famous Embargo in 1807. In the following year a poet at Marietta wrote:

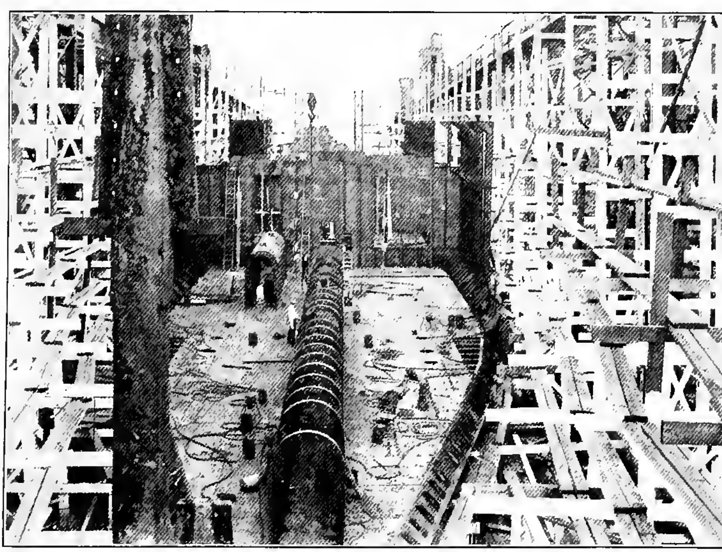
"Our ships all in motion
Once whitened the Ocean,
They sailed and returned with a cargo;
Now doomed to decay
They have fallen a prey
To Jefferson, worms, and Embargo."

The general revival of the industry has not been felt in these centers to quite the same extent as in other re-



THE FIRST PLATES ON THE LOWER DECK

At this stage, ship carpenters begin to erect the scaffolding about the berth. They place the shoring timbers under the hull and keep the ship trued up as erection goes on



AFTER SEVERAL WEEKS OF WORK BY GANGS OF ERECTORS, DRILLERS, REAMERS, BOLTERS, AND RIVETERS

gions. Of most interest has been the development of plants for rolling and fabricating ship steel in the vicinity of Pittsburgh.

In connection with the Southern shipyards it is interesting to note the place that is being taken by the negro in the present conflict. The great need of the war is ships, and the great need of shipbuilding is workmen. In the South workmen must be drawn mainly from the black race that has produced for the world the immeasurable riches of the Southern cotton-fields.

The negro and the negro country of Africa are among the not remote causes of the war. The warring European nations hold large, rich African possessions, producing gold and diamonds, cocoa, rubber and ivory, palm oil, and other products. These nations have long vied in rivalry for African territory and trade.

Fighting in the French Army are thousands upon thousands of men from the French colonies. These men came voluntarily because they loved France, their mother country that stood for Liberty, Equality, Fraternity. These men fought in the first battle of the Marne, and helped to save France. There are colored troops in the regular British Army on all fronts, fighting shoulder to shoulder with white soldiers. The United States has already enrolled over 150,000 American negroes, and many other thousands are still to be enrolled. In our Army there are already over one thousand colored commissioned officers.

A recent editorial from the "New York Times" is illuminating and suggestive. It is as follows:

Like a pathetic romance runs the story of our soldiers in black. Too little has been told about them by the writers of American history. A better understanding between the races

might have long ago materialized had a page or two here and there from the musty old government reports and official war records, long buried in the dustiest corners of big libraries, been inserted in the textbooks on American history, giving the negro's part in the Nation's wars.

There are ten million negroes in America. Early in the war the call to the colors by the European countries carried over many thousands of industrial workers from the North. Following came the sudden and unprecedented demand for war munitions and other supplies, and negro labor from the South was the only large available supply to fill the need. Thus it became at once an important division of our present industrial army, and we have a considerable increase in the negro population of the Northern States.

The negroes of the South are manning the Southern shipyards. Even as far north as Newport News about one half of the shipyard workers are of the black race. In shipyards, steel mills, and munition plants throughout the country that race is found in increasing numbers. In the present war appears the long-desired opportunity to draw the race from its narrowed environment and sphere of activity and to show the world what the negro can do in industry.

It must, of course, be understood that these changes will take place only by degrees, through long processes of overcoming trade traditions and providing the right kind of education for the negro. At Newport News, for example, certain kinds of first-class work may be entered freely by the negro. He works side by side with white laborers, with equal pay, on such tasks as riveting, reaming, chipping and calking, or erecting. In these, as well as in many other tasks, the negro has repeatedly demon-

strated his ability to perform work requiring a high degree of skill.

One of the fundamental remedies for unemployment in the South, as in the North, is to be found in the right kind of industrial education. Provision for the proper kind of training means that unskilled workmen will be transferred into the more skilled classes, and that skilled labor will be promoted to the scarcer and more needed work of management. Lack of vocational preparation and traditional limitations have tended to keep the negro in the army of the unskilled and the unemployed. Professor Carver's analysis has a clear application to the situation of the negro in the shipyards to-day: "Upon the redistribution of labor power upward from the unskilled and overcrowded occupations toward and into remunerative occupations depends, more than anything else, the expansion of our industries. It takes no miracle to bring this about; it requires only education."

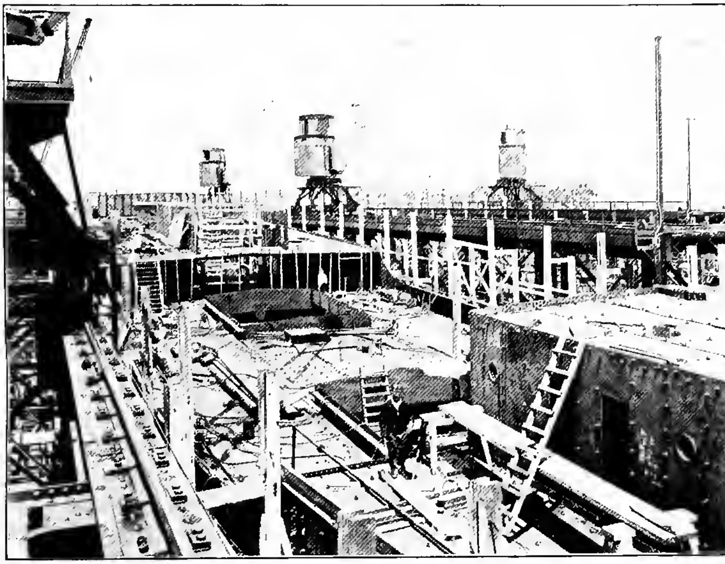
Shipbuilding on the Western Coast is of much more recent development than in other parts of the country. The Eastern, Southern, and Central sections of the United States, including the Lake region, had an increasing commercial activity after the opening up and settlement of each portion, from early colonial times down to the period of great expansion following the Revolution and culminating at the present time. Settlement and development in the West, on a degree of any magnitude, began with the discovery of gold in California, continued unbroken for fifty years, and received a great added impetus by the discovery of the Alaskan gold fields. With the development of agriculture, lumbering, mining, and manufacturing, commerce on the Pacific steadily increased, and shipbuilding was a necessary in-

dustry from the start. Nor did it suffer such a decline as came in the East and South from railroad development and other causes.

The great forests of the West and Northwest were long ago a contributory factor in the building of wooden ships, and during the last year have led to the building of numerous wooden shipyards under the Emergency Fleet Corporation. Eastern shipbuilders have in some cases gone clear across the country to locate yards where lumber and labor were more plentiful. No better example can be found of the astounding growth of the shipbuilding industry in the United States than the development of the shipbuilding facilities of The Foundation Company, of New York.

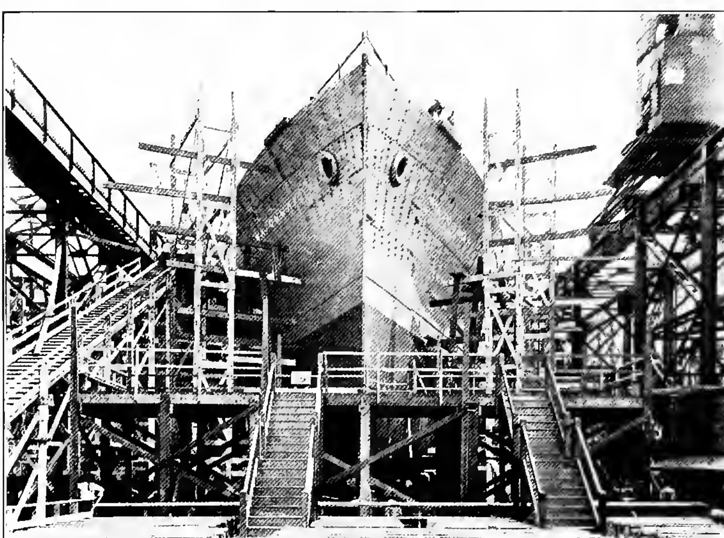
One year ago this company was equipping its first shipyard for the construction of ten wooden steamers for the United States Shipping Board. It is now operating yards on the Pacific Coast, the Atlantic Coast, the Gulf, and the Great Lakes, and has under contract a total of ninety-eight steel and wooden ships for the Governments of the United States, Great Britain, and France. Nineteen of these ships have already been launched and others are following at the rate of ten a month. The Foundation Company was the first of twenty-three competing yards on the Atlantic and Gulf Coasts to launch a wooden ship for the Emergency Fleet Corporation.

The leading yards of the three great states on the Pacific Ocean are in the following places: San Francisco, San Pedro, Alameda, and Longbeach, California; Astoria, North Bend, Marshfield, and Portland, Oregon; and Aberdeen, Seattle, and Tacoma, Washington. About three fifths of the hundred thousand men in these yards are building steel ships, there being a total of 88 steel



LOOKING DOWN ON THE UPPER DECK OF A FABRICATED SHIP AS SHE NEARS COMPLETION

The open cargo hatches are shown in the center



NEARLY READY FOR LAUNCHING

The greater part of the machinery, many of the deck fittings, and the work of the joiners and sheet metal workers are installed at the outfitting pier after launching

ways in the ten cities. In the year ending May 1, 1918, Washington, Oregon, and California launched 202 steel ships, of which 100 were launched in the first four months of 1918.

The Great Lakes have served as an inland sea, affording traffic among the Lake States, between this country and Canada, and from the Lake States to the Atlantic Coast. They are situated in a region rich in agricultural and mining resources. They have an outlet to the ocean through the Welland Canal and the St. Lawrence Canal and River. The locks of the Welland Canal limit the length and width of beam of vessels that may pass through. A ship cannot be longer than 261 feet, nor wider than 42 feet and 6 inches. These restrictions fix somewhat the tonnage of vessels completed in the Lake shipyards, causing them to range between 3500 and 4000 tons' burden.

While large ships cannot sail through these canals, one yard, at Bay City, several years ago constructed several great steamers for trans-Atlantic service and took them through by cutting them in two and putting in temporary bulkheads. The parts were reassembled, and the vessels finished, at tidewater in the St. Lawrence. A better, newer, plan has recently been adopted, so that larger steamers than ever before will now be constructed in the Lake yards. Steamships built here are to carry to the Atlantic Coast fabricated, or prepared, material to increase their length by ninety-six feet. The width, however, cannot be increased, so the capacity of a properly proportioned ship cannot be increased beyond about 5500 tons.

Shipbuilding has been kept in greater activity in the Lake region, perhaps, than upon the coasts during the period of decline in the mercantile marine.

There are shipyards of considerable capacity at Buffalo, Cleveland, Lorain, Toledo, Wyandotte, Detroit, Bay City, Saginaw, Port Huron, Chicago, Manitowoc, Superior, Duluth, and Sturgeon Bay.

On June 30, 1914, there were on the Great Lakes 2339 steam vessels of 2,523,517 tonnage. One hundred and thirty-one ships were built in the Lake yards in the following twelve months, and the yards have been working at full capacity since. They will launch about one hundred and twenty ships this year.

The shipbuilding and commercial activity of the Great Lake Region have been graphically described by the Honorable Crawford Vaughan, former Premier of South Australia, in "The Outlook" for July 3, 1918. Mr. Vaughan's account is in part as follows:

I boarded the midnight express for Buffalo on Tuesday, April 24, on a tour that was mapped out by the National Service Section of the United States Shipping Board, Emergency Fleet Corporation, of which Dr. Charles A. Eaton is the head, to encircle the United States. My ticket measured five feet in length. It covered nearly nine thousand rail miles. My mission was to help speed up shipbuilding by addressing shipworkers in every shipyard from Buffalo to Seattle, from Seattle to San Diego, and from San Diego to the Hampton Roads. . . .

I had been inspired with the magnitude of the shipyards on the Atlantic seaboard, I had seen something of the keelways on the Pacific, I had heard of the great preparation of the Gulf ports not to be behind any other coast in the production of tonnage. But of the Great Lakes shipyards little was known to me, or is known to-day, I believe, to the general American public. Yet these Lake shipyards are doing a great National work, and are doing it under singular difficulties. Ice-bound for the winter months, subject to a temperature of 40° below zero at times, and limited in their launchings by the Welland Canal, the Great Lakes do not, on the face of things, appear to offer great facilities for the output of ocean-going vessels. . . .

That the Lake shipyards can turn out mammoth boats is revealed in the great fleet of ore freighters which carry coal and iron ore between Superior and the shores of Lake Michigan. There is nothing more impressive on the face of the waters, unless it be a warship, than a long-nosed, black-hulled leviathan pushing its relentless way through the breaking ice or up against the ore bins, there to load up with a freight that shortly will be transformed into rails or roaring engines, into boiler plate or big guns, or into steel that will go screaming into the German lines in the form of shells.

These great ships, with their smokestacks astern, are in some instances 625 feet long, 60 feet in beam, 20 feet draught, and, with their 2000 horse-power and averaging 10 knots, carry as much as 13,000 tons of ore in a single haul. It takes only two and a half hours to fill up all the holds of such a ship with the red iron ore, and a little longer to unload, such is the character of the labor-saving machinery installed at the inland ports of America. A boat of 10,000 tons will pull alongside a wharf, say, at Cleveland, or Toledo, at ten in the morning, empty herself of 10,000 tons of iron, load up with coal, and be steaming out by five o'clock in the afternoon.

Duluth Harbor claims to be the second port in the world in point of tonnage shipped. It has long since outdistanced Liverpool's total.

In July last year it was estimated that 700 tons of freight were loaded or unloaded at the Duluth-Superior wharfs and docks every minute of the twenty-four hours per day. Upon the Great Lakes themselves is borne a commerce of 100,000,000 tons annually, and there is no place in the world that approaches the Lakes for cheapness in the handling and hauling of its water-borne commerce. Ore and coal were hauled in pre-war days to and from Superior to Lake Erie ports, one thousand miles away, the round trip costing a dollar a ton, or one twentieth of a cent per mile.

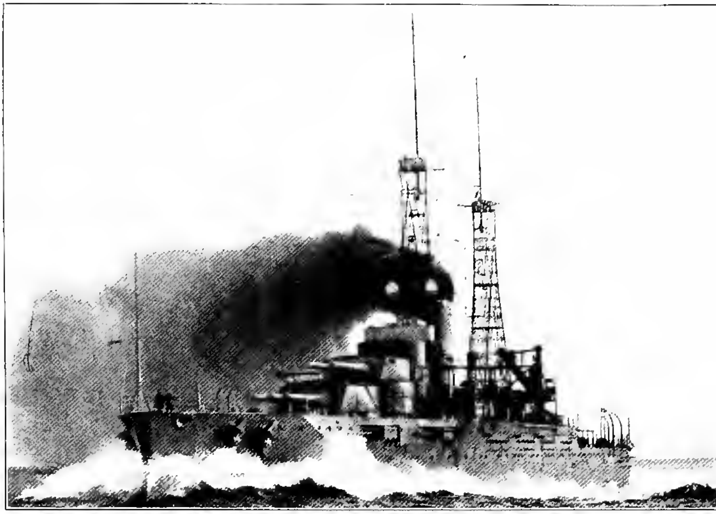
The tonnage now under construction in the Great Lakes shipyards on behalf of the Emergency Fleet Corporation is an ever-increasing one. Old yards are expanding as though the wand of the magician had been waved over them. New yards are being improvised along inland waters whose quietude was

never before disturbed by the whiffing rattle of the riveting machine. Still further yards are projected in placid upper river reaches that till now have launched no other boat than the Indian canoe.

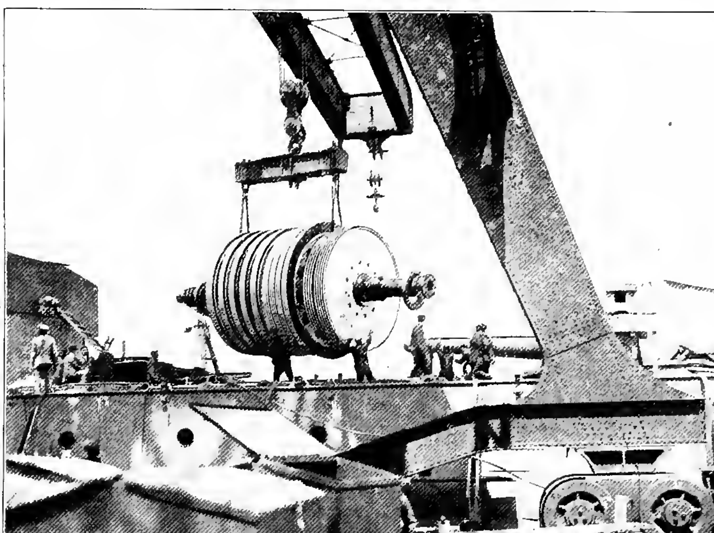
These centers include places having steel mills and large machine shops which are temporarily turned to the fabrication of parts of the steel ship. Such prepared parts are brought from the mill and shop to a shipyard on a water front where they are assembled and launched. The machine shops of the country have, however, in most cases been turned into munition factories rather than steel fabrication shops. On the other hand, many structural steel shops can easily prepare the frames and plates, by added work upon them, for immediate installation in a shipyard.

The United States has gradually built up a powerful navy. The chief purpose, however, has been one of defense rather than offense, as it has been considered that the great extent and resources of the country and its isolation between the two great oceans of the world rendered it safe from attack by any foreign power. Navy yards, for the maintenance and repair of our ships of war, have been established at strategic points upon the various coast lines. The principal yard is at Brooklyn, New York. Other important yards are at Norfolk, Virginia; League Island, Pennsylvania; Charlestown, Massachusetts; Mare Island, California; and Bremerton on Puget Sound. There are less important ones at Portsmouth, New Hampshire; Charleston, South Carolina; and Pensacola, Florida.

The Government has constructed warships steadily, although on a conservative basis of defense. There have been constructed each year, under acts of Congress one or



U.S.S. NEVADA ON HER TRIAL TRIP AT ROCKLAND, MAINE



SWINGING THE ROTOR FOR THE MAIN TURBINE ON BOARD THE BATTLESHIP NORTH DAKOTA

Both these ships were built by the Fore River Plant of the Bethlehem Steel Corporation at Quincy, Mass. This yard has built a number of battleships, destroyers, and submarines

two battleships, and several each of other kinds of ships demanded by the Navy, ranging from the mighty dreadnaught to the swift coast patrol. These have been built both in the navy yards of the country and in private yards under contract. On the other hand, shipbuilding for commerce has been a private undertaking, favored and encouraged in the main by the National Government, yet depending upon individual shipbuilders and usually upon private capital.

The completion of the Panama Canal is likely to affect the future of American shipbuilding in numerous indirect ways. The project of a canal across the Isthmus of Panama is as old as American history. Balboa and other early American explorers proposed the matter to the Emperor of Spain early in the sixteenth century. They also made surveys of possible routes across the Isthmus. Interest in the project was aroused again after the last of the South and Central American provinces of Spain became independent in 1823. At the close of the Mexican War, in 1848, Texas and California were ceded by Mexico to the United States. This created a Pacific coast for the United States and made a quick route there almost imperative. The story of the building of the Canal, from the first concession granted by the Republic of Colombia to Lieutenant Wyse in 1878 to the completion of the Canal by Colonel Goethals in 1914, is well known.

The opening of the Canal has had a far-reaching effect both upon war and upon commerce. It enabled our country to send half of its Navy to the Pacific, for protection of our interests on the Western coast. It has been said that the Canal doubles the size of the American Navy. The Canal now enables us to withdraw both ships of war and merchant ships quickly from the Pacific to the At-

lantic. Of necessity we are now yielding the coast trade to Japan and England. When the war opened our ships carried twenty-six per cent of the Pacific trade, Japanese ships the same amount, and English twenty-nine per cent. In May, 1916, Japan carried fifty-one per cent, and England thirty-seven per cent, of Pacific commerce, while American ships carried two per cent. Now Japan takes away seventy-nine per cent of our Pacific exports and brings in seventy-three per cent of the imports.

The capacity of the Canal is sixty average ships a day, while it was expected that only forty-eight could be passed through. Our main battleship fleet of twenty-one vessels can be passed through the Canal in one day.

In the first year of the use of the Canal, from August 15, 1914, to August 15, 1915, 1317 vessels, with a tonnage of 4,596,644, passed through, yielding in tolls $5,216,149.

The time of passage is from ten to twelve hours, through this great highway between two oceans and two worlds. No longer must ships make the long and dangerous journey around South America. Great distances are saved in ocean travel, as indicated in the following paragraphs which show the main lines of ship traffic:

The old route to New York from San Francisco, by the Strait of Magellan, was 13,135 miles. By the Canal the new route is 5262 miles, a saving of 7873 miles.

The distance from New York to Yokohama is 2947 miles less by Panama than by the old route through the Suez Canal.

From New York to Sidney, New South Wales, there is now a saving of 4710 miles.

From New York to Valparaiso and other Chilian ports there is now a saving of from 3800 miles to 5200 miles.

San Francisco is now 5210 miles nearer to Brazil, 5405

miles nearer to Liverpool, and 5092 miles nearer to Gibraltar than formerly.

A large portion of the commerce of the world must continually pass through the Panama Canal and the shortened highways of ocean travel. Fortunately the Canal was ready for use at the beginning of the present war.

There are four aspects in which the opening of the Panama Canal is peculiarly important:

1. The Eastern and Western coasts of the United States will be drawn closer together. They have had different interests. The West yields the raw materials of industry and foodstuffs. The East is industrial. Their interdependence will become more and more a source of union.
2. The West Coast of North America will be made accessible to the world. The rich lands of the Pacific Coast will be populated and developed more rapidly than ever before.
3. The states and peoples of South America are drawn decisively nearer to us. More than ever is it clear that there is a Pan-American entity.
4. Japan and the Pacific Coast are drawn more closely together into a common area of trade and commerce.

When Columbus started across the sea he was seeking, not America, but the old Orient, India and China and their riches. The way now lies open from the Occident to the Orient.

To man the many ships that are being added to our merchant fleet the Government has established a Recruiting Service. The plans of this department are already very definite. All ships that carry troops and war supplies will be manned by the Navy Department. For

most other ships men must be secured and trained, although there are a few able seamen to be found in various parts of the country.

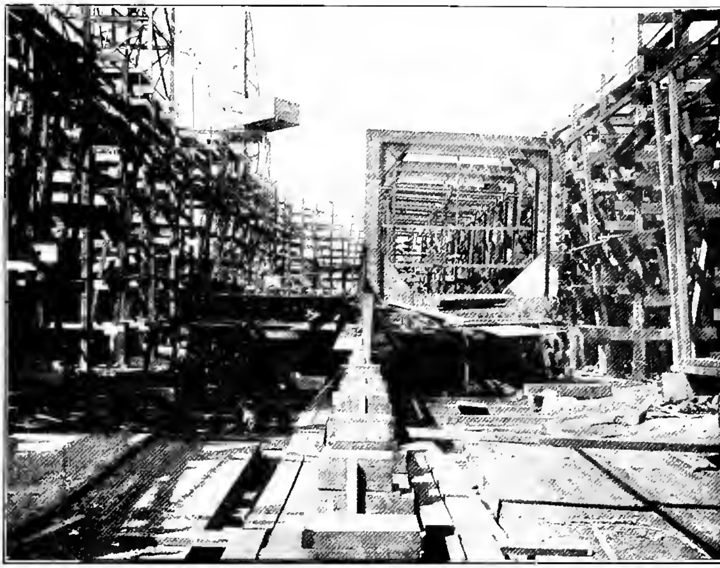
The Director of the Recruiting Service has made an estimate of the number of men needed to man the merchant ships to be built in 1918. Figuring liberally that the tonnage will be over 5,000,000, the following numbers of men will be needed:

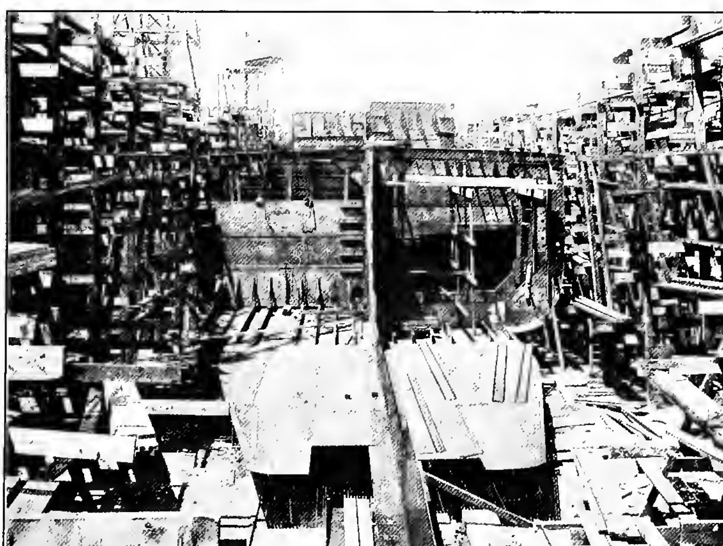
Deck officers	4,116
Engineer officers	4,116
Stewards	1,044
Deck crews	10,708
Engineering crews	16,917
Stewards' crews	7,014
Total	43,915

To this total must be added gun crews and crews for the seventy-seven Dutch ships in our harbors, of 600,000 tonnage, taken possession of by the Government on March 21, 1918. Probably, then, in addition to seamen already available from scattered sources and from the Navy, about 50,000 men must be found and trained to sail our augmented merchant fleet in the present year, with a possible large increase in time to come.

As a result a series of schools has been established for turning out sailors and officers. Free schools for navigation, for training seamen to be officers, have been opened at Cambridge and at Gloucester, Massachusetts; Portland and Rockland, Maine; Baltimore, Newport News, New York, Norfolk, Philadelphia, Jacksonville, Tampa, Galveston, Mobile, New Orleans; Los Angeles, San Diego, San Francisco, Eureka, California; Bellingham, Washington; Portland, Oregon; Tacoma and Seattle.

Free schools where marine engineering is taught have





PROGRESS PICTURES OF A STANDARD OIL TANKER

These two views were taken 63 days apart in 1916. The entire hull would be built in nearly half that time now

been established at the Massachusetts Institute of Technology in Cambridge; Stevens Institute in Hoboken, New Jersey; Johns Hopkins University in Baltimore; one in Philadelphia in connection with the Bourse; Tulane University at New Orleans; University of Washington at Seattle; Armour Institute of Technology at Chicago; and the Case School of Applied Sciences at Cleveland.

The Recruiting Service has organized a Sea Service Bureau. This is intended as a follow-up system, so that men may not give up their time and energies to fit themselves for the sea and then find no berth. Consequently, this Bureau sees to it that the men find employment. If they are of draft age, they are exempt upon application of the Fleet Corporation, so long as they stick to their agreement to go to sea.

In order that the many men who will be turned out as ordinary seamen may not lack for work, arrangements are being made whereby they can be put into the regular shipping service. Two able seamen are taken out of the ship roster and four ordinary seamen, graduates of the Fleet Corporation School, are put in their places. An able seaman is one who has had three years' active service at sea.

It is interesting to note the condition of the world in merchant shipping at the end of 1915 as given in "Lloyd's Register." Here are presented the number of ships and the total tonnage of each country that has entered at all into world commerce with its shipping. A comparison of these figures with those given on page 55 for the year 1918 makes it plain that the United States stands in a position to take her proper place among other large nations in carrying on the world's commerce, and is earnestly engaged in building up a merchant marine.

STEAM AND SAILING VESSELS
OWNED ACCORDING TO LLOYD'S REGISTER BOOK
1915–1916

Flag	*No. of ships*	*Tons*
United Kingdom	9,285	19,541,364
British Colonies	2,068	1,732,700
United States	2,580	3,522,913
Austria-Hungary	433	1,018,210
Danish	835	854,966
Dutch	809	1,522,547
French	1,539	2,285,728
German	2,166	4,706,027
Italian	1,177	1,736,545
Japanese	1,155	1,826,029
Norwegian	2,174	2,529,188
Russian	1,256	1,054,762
Spanish	642	890,204
Swedish	1,462	1,122,883

The astonishing growth in our shipping since 1915 is very well summed up in the following statement issued by the United Press on July 26, 1918, and corrected by the Emergency Fleet Corporation to September 30, 1918:

The Shipping Board, since its creation, last September, has placed 2,267,131 deadweight tons of vessels in service. Three hundred and ninety-two seagoing ships, of seagoing capacity, have been commissioned. This does not include the scores of ships already built and owned by American citizens.

Besides the 392 bottoms completed, nearly 400 other hulls are afloat in various stages of completion. These will aggregate approximately 1,800,000 tons.

Two hundred and three shipyards are engaged in producing ships with which to transport men and materials to the front. Keels have been laid or will be laid on more than 871 ways, and 350,000 men are doing their bit in the shipyards of the United States.

Here is the rate at which the ships have been completed and placed in service by the Shipping Board and Emergency Fleet Corporation:

	No. of ships	Deadweight tonnage
1917		
September	8	43,424
October	12	81,985
November	18	79,410
December	11	96,990
1918		
January	11	91,441
February	16	124,650
March	20	162,200
April	30	162,805
May	43	259,041
June[1]	49	282,922
July	44	251,565
August	66	340,145
September	73	363,645
Grand totals	401	2,340,223

According to an official statement of September 26, 1917, the United States had available on that date 3,500,000 tons of merchant shipping, including that commandeered and requisitioned from German and Austrian owners. Since that time 700,000 tons of Dutch shipping have been secured. There were under construction in the year 1917 in our American yards about 6,000,000 tons of shipping. This all made an aggregate of more than 10,000,000 tons at the beginning of 1918, and the contracts let to our yards both old and new during this year total several million tons more. In the meantime contracts have been let by the Emergency Fleet Corporation for the building in China of 40,000 tons of steel cargo ships and in Japan of thirty vessels aggregating 245,850

[1] Figures for the last four months include 73,092 tons built in Japan.

tons. The grand total of the American merchant fleet, built or to be built, is in the neighborhood of 16,000,000 tons, a larger amount than has been owned at any one time in the history of the world by any other power than the entire United Kingdom. Chairman Hurley of the Shipping Board has recently stated that our tonnage will be 25,000,000 by 1920. Indeed, Director-General Schwab of the Fleet Corporation has said that the shipyards of the country, when working at their full capacity, will turn out yearly 1200 steel ships, with a tonnage of about 10,000,000, and 1200 wooden ships, with a tonnage of over 4,000,000. This makes possible an unprecedented total of 2400 ships or over 14,000,000 tons each year.

The wanton destruction of American ships and American lives upon the pathways of the seas brought America into the conflict; the building of American ships shall win the war and maintain the freedom of the seas to all posterity.

CHAPTER III

PRODUCTS OF THE SHIPYARDS

A SHIP is a large boat or vessel constructed for deep-water or deep-sea navigation. Technically, the term was first used for a vessel carrying three masts or more, and rigged with square sails. As determined by motive power, there are now two kinds of ships — sailing vessels and steamships. As determined by materials used in the construction of ships, there are vessels of wood, iron, steel, and concrete. As determined by use, there are many kinds of ships, such as the wooden merchant or passenger ship or the old "sailing vessel," the iron or steel steamship, passenger steamer, ocean liner, special freighter, cargo ship, fabricated ship, reinforced concrete ship, troop transport, battleship, battle-cruiser, torpedo boat, torpedo boat destroyer, submarine, and submarine chaser. These names are frequently confused in use, and several of them may be applied to the same kind of vessel. Neither do they include all kinds of craft afloat, such as the yacht, pleasure motor boat, fishing boat, whaling vessel, lake or river steamer, ferryboat, or hydroplane.

The leading qualities demanded in a ship are stability, capacity, strength, and speed. The utility of a vessel depends upon these four factors in combination. Stability depends upon the proportion of the parts of the ship, load adjustment, and displacement. The displacement is the volume of water displaced by the ship when afloat. The weight of this volume of water equals the combined

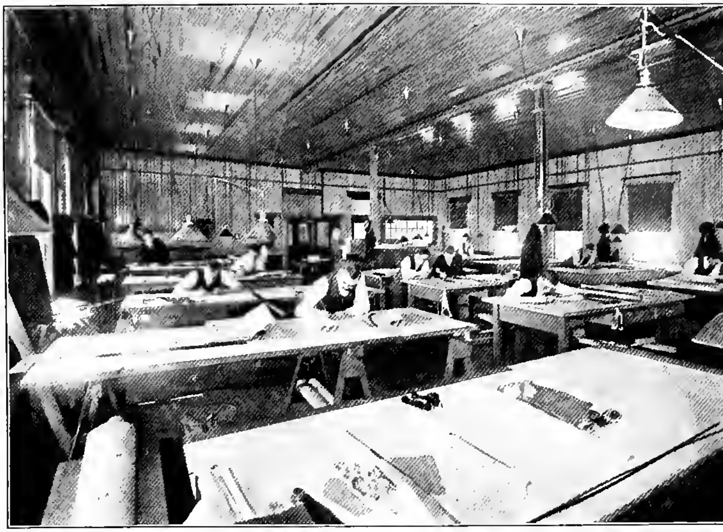
weight of the ship, equipment or armament, crew, passengers, cargo, and stores. Capacity is the power of carrying cargo, stores, crew, and passengers.

Until comparatively recent times, or up to about the middle of the last century, wood was the only material used to any extent in shipbuilding. It is now used mainly for small yachts and boats. The woods used most commonly in ship construction are oak, teak, cedar, pine, beech, and elm. One kind of wood is found to fit one purpose best, and another, another purpose, according to the strength, firmness, toughness, or lightness demanded.

The various kinds of vessels, as determined by building material, use, and standards of construction, are presented briefly in the following paragraphs.

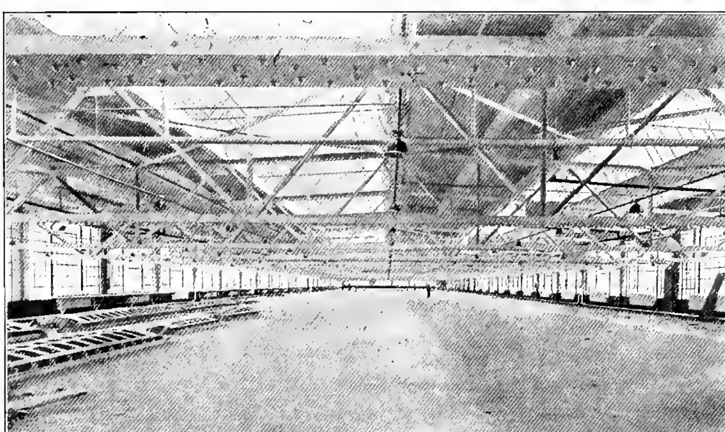
The development of the wooden ship has followed the advancement of civilization and the state. For eight thousand years it can be traced in illustrations on ancient coins and vases, in terra-cotta and wooden models, and in mediæval paintings and art adornment. The course of this development runs from Egypt and Phœnicia down through Greece and Rome, northern and western Europe, and farther west still to America. At the same time the less civilized races have had their primitive boats and ships, such as the well-known "junk" of China and Burmah.

Perhaps the first boat used by man was suggested by the floating log. At least it is quite certain that the first boat was simply a log hollowed out on one side by the hand of man. This rude form has been long used by the natives of the tropic islands, sometimes being made large enough to carry eighty or one hundred men, and propelled both by oars and rudimentary sails. The progressive races soon enlarged this form of boat, splitting the



A CORNER IN A DRAFTING ROOM

Hundreds of drawings are required for each ship. Standardized shipbuilding has greatly reduced the number of persons needed in these departments in proportion to the number of ships being built



A MOLD LOFT FLOOR

From the drafting room the plans go to this loft, where lines are drawn on this floor to full-size scale for each part of the hull

hollowed log and inserting planks to give greater width, and finally planking over a wooden frame. For lightness and speed the frame was sometimes covered with the skins of animals and the bark of trees. The canoe of the American Indian and the racing shell of the modern university are of this one type.

The type of wooden ship that can easily be traced from Egypt through Europe to our own country has had characteristic form from the first, determining the world's shipping to-day. The long sweep of the ship body has given grace and speed, and the high bow and stern have yielded dignity and safety in breasting the waves of the deep sea. Indeed, a ship has a personality in the minds of men the world over.

The famous Roman galley, driven by two or three banks of rowers on each side, was a modification of the general type of sailing vessel. It was from one hundred to one hundred and fifty feet long and but ten, twelve, or fifteen feet wide with flat keel. It was constructed for speed and ease of movement, and was especially adapted to ramming an enemy ship. It survives to-day as a boat for business and pleasure in the Venetian gondola. Greek and Roman merchant ships were predecessors of those of commerce in the later centuries. The general lines of Egyptian ships, of the prehistoric vessels of Norway, of the sea craft of the Vikings, and of the Baltic ships of the present age are the same.

Furthermore, the rigging of ships has been substantially the same from the square sail of the Egyptians which was used by the Greeks and Romans, by the Vikings, and by Norwegian and Russian ships even up to the present time. Sails of other shapes have been added, and an increasing number of masts, yards, and stays. There

has been from the first much the same method of harnessing the wind as motive power.

The eyes painted by the ancients on the bow of the ship survive in the hawse holes of to-day. The belief of the ancients that by means of these eyes the vessel could see her way on the pathless ocean was but an expression of the universal creed that a ship, out of all the creations of man, is a living thing. The decoration of the bow and stern of a vessel has existed for many centuries. The figurehead of the Middle Ages now survives in the yacht and other pleasure craft. The introduction of the steamship, however, ushering in the utilitarian age, discouraged fanciful and unnecessary adornment.

The wooden merchant ship found its highest development in the middle of the nineteenth century, preceding the extensive use of steam. The American "clipper" ship was the finest up to its time. Since the clipper we have developed a larger ship of five or six masts. In the Spanish galleon and the English "wooden wall" appeared the precursors of the later wooden battleship. It was built simply with more strength and weight, to carry cannon and to withstand the shock of battle.

The power and romance of the sailing ship, as wooden ships have generally been known, are well indicated in the following quotation from "Sailing Ships" by E. Keble Chatterton:

> Sailing ships are the links which bind country to country, continent to continent. They have been at once the means of spreading civilization and war. It is a fact that the number of new ships to be built increases proportionately as the trade of a country prospers, and one of the first signs of bad trade is the decrease in the shipbuilder's orders. But, good trade or bad trade, peace or war, there will always be a summons in the sea which cannot be resisted. It summoned the Egyptians to

sail to the land of Punt to fetch incense and gold. It summoned the Phœnicians across the Bay of Biscay to the tin mines of Cornwall. It called the Vikings to coast along the Baltic shores for pillage and piracy. It called the Elizabethans to set forth from Bristol and London in order to find new trade routes, new markets for their goods, fresh sources of their imports. It calls some for trade, some for piracy, some for mere adventure, as in the case of the yachtsman of to-day. It seduces the ships from the safety of snug harbors only to be tossed about by the billows of a trackless expanse. The sea ever has been, ever is, and ever will be, uncertain, fickle, unkind. In spite of the fact that for eight thousand years and more shipbuilders, designers, and seamen have by experience and invention sought every possible means to overcome its terrors and to tame its fury; in spite of the fact that these men have never succeeded in getting the upper hand, yet the call of the sea will ever be obeyed. When once she has fascinated you, when once you have consented to her cry and got the salt into your veins, you become as much the slave of the sea as any Roman underling that pulled at the oar of an ancient galley. The sea calls you; you hoist up your sails, and come.

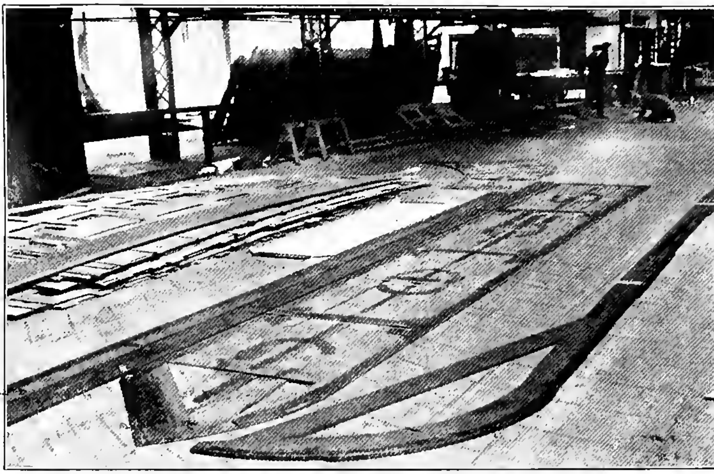
Iron has been worked for thousands of years in many parts of the earth. Yet it was not used to any extent in shipbuilding until about eighty years ago. The first iron ship in this country, the Bangor, was constructed at Wilmington, Delaware, in the shipyards of Betts and Pusey, in 1843. The ironclads of the Civil War, the Monitor and the Merrimac, are well known. But not until about 1860 could steel be produced in sufficient quantity and suitable quality for any considerable use in the construction of ships. By 1880 it became extensively employed. At the opening of the European War ninety-nine per cent of our ships were of steel. Iron and steel in various forms are used in wooden ships, for masts, iron castings, malleable iron plates, bars, forgings, and other parts.

THE SHIPBUILDING INDUSTRY

When steel was first introduced in the construction of ships, its chief advantages lay in the fact that it could be manufactured in large-sized pieces and that the various parts of the structure could be fastened together much more securely than in the case of wood, thus making larger ships possible. The distinguishing feature is the use of rivets in shipbuilding. The great problem in the use of iron and steel was that of finding some means of fastening the frames and plates firmly together and making water-tight joints. This problem was solved by the modern development of riveting and calking. Riveting may, indeed, soon give way to another method of fastening plates in steel ship construction. Announcement has just been made that a steel barge has now been constructed in an English yard without the use of rivets. The plates of this ship have been joined together by means of a new electric welding process.

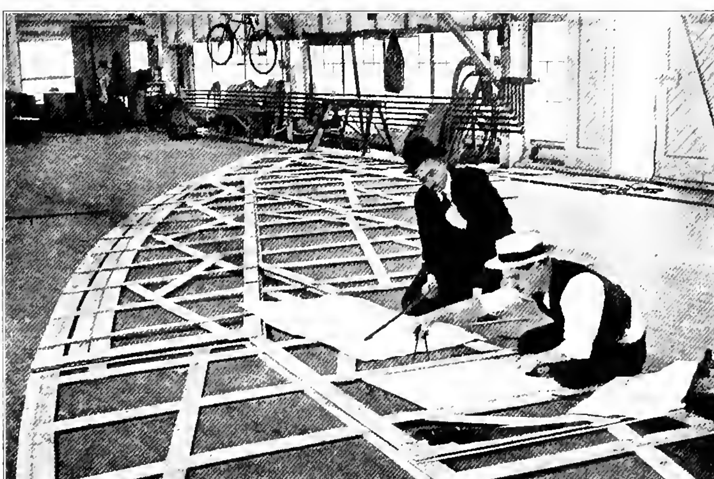
The problems raised in previous naval warfare as well as in the present war, have aroused naval designers and engineers to their best efforts for improvements in the construction both of ships of commerce and of war. The present war has so far produced four distinct types of vessels, the standardized and fabricated steel ship adopted by both England and the United States, the reinforced concrete ship, the large troop transport, and the submarine chaser. The Naval Consulting Board of the United States, which is the final authority on design and construction, has recently issued the following statement as to efforts now being made by special ship construction to meet the danger of submarine, mine, or torpedo:

> The explosion of a near-by submarine mine or torpedo frequently tears great rents in the ship's plating, in some cases opening a jagged hole ten feet or more across. The destruc-



TEMPLATES AND THE LINES ON THE MOLD LOFT FLOOR

The wooden or paper template is used for marking steel plates or frames for punching, cutting, or bending



A STUDENT LEARNING TO LAY OFF THE MARKS ON A TEMPLATE FROM A BLUE-PRINT

tive effect at any given distance, at the point of explosion, depends, to a large extent, upon the framing and plating, and may be greatly diminished by special hull construction.

Many suggestions are made for ships of unusual form to provide for safety in case of such explosions; most of these plans being an elaboration of the usual water-tight bulkhead construction, now required in structural design for all modern ships.

The multiplicity of water-tight compartments in any hull design tends to add to the vessel's safety. The modern tank steamer, used to carry fluid cargo, such as petroleum products or molasses, is a good example of this design, which has been in general use for many years.

The honeycombing of hulls with air cells has been proposed in an infinite number of variations, and air tanks, such as are now used on life-rafts, have also been suggested in various proposed arrangements for installation within the hulls of vessels.

The ordinary self-baling lifeboat, such as is used by the Coast Guard Service, probably represents the most highly developed form of non-sinkable ship that can be constructed. Its hull is filled with numerous water-tight cans or boxes, so that injury will merely admit water to the space occupied by the boxes and only a little reduction of the buoyancy of the boat will occur, as each box is an individual float. It is very unusual for a lifeboat of this type to sink even though the hull is badly wrecked.

The object of a passenger vessel is to carry passengers, of a freighter to carry freight, and of a war vessel to carry offensive armament. Air cells and water-tight compartments in their various forms decrease the convenience and carrying capacity of the different types of vessels, and the problem which has to be solved for each type is one of over-all efficiency. In other words, how much capacity is the designer justified in sacrificing in order to increase the safety from torpedo attack?

So experiment and invention are still going on. One invention of unusual interest is that of a device to raise sunken steel ships. An electrically driven diving machine,

designed to make possible the recovery of steel vessels sunk by German submarines, has recently been given a successful private test in Long Island Sound. The machine, which carries a crew of two men, is equipped with propellers capable of driving it directly to the side of a submerged vessel, to which it clings by means of magnets. Power is generated on a surface barge and transmitted by cable. A riveting attachment is intended to fasten pontoons to the vessel. In the test the machine went down in ninety-eight feet of water and brought to the surface a heavy steel plate.

The great trade routes of the sea are naturally of interest in connection with our production of cargo and passenger vessels. These routes may be outlined as follows:

1. The North Atlantic.
2. The North Sea and the Baltic.
3. The Mediterranean, Southern Europe, and the Black Sea.
4. India, China, Japan, and the Far East.
5. Australia, New Zealand, and the South Seas.
6. The African.
7. The South American.
8. The Pacific.

American foreign-going ships are chiefly engaged in the North Atlantic and Pacific trades and travel. The American flag rarely appears on the other great sea routes, but it will no doubt be seen in those regions more frequently following the present war.

Some of the well-known lines have been the Pacific Mail Company, of the Civil War period; the American Line, running to Europe; the New York and Cuba Mail Steamship Company, running between Boston and Philadelphia; the Red "D" Line, running between New York

and Venezuela; and the Oceanic Steamship Company, running to Australia, Tahiti, Honolulu, and San Francisco.

The great passenger steamship lines between America and Europe have been mainly of English and German ownership.

There are now about 11,000 American-owned sailing ships, against 18,000 of thirty years ago. The gross tonnage, however, has changed but little within the thirty years. As has already been indicated, steel ships have been taking the place of wooden ones during this period.

The commercial steamships that are in general use are of four classes—passenger, liner, special freight, and tramp.

Passenger steamers are of the highest class. The best of them are run for a strictly passenger service. They have very little freight space. The largest can probably carry only about 1500 or 2000 tons of cargo. The Mauretania has a crew of over 1000 and consumes 6700 tons of coal between New York and Liverpool. It is clear, then, that such a ship could not afford to do an extensive freight business; it must, indeed, carry a large number of passengers at the highest possible prices to pay dividends upon the building and sailing costs.

There has been great development in recent years in vessels used for passenger service, especially in the great trans-Atlantic lines plying between Europe and America. Travel was becoming more and more general and of rapidly increasing importance up to 1914, when the war broke out. The New World was turning to the Old World, and drawing from its rich stores of learning, arts, and crafts, as never before. Steamship lines were performing a distinct national service. Steamers became veritable floating hotels and palaces.

Two of the first magnificent steamers built were the

Campania and Lucania, built for the Cunard Line in 1893, at Glasgow. Their principal dimensions were:

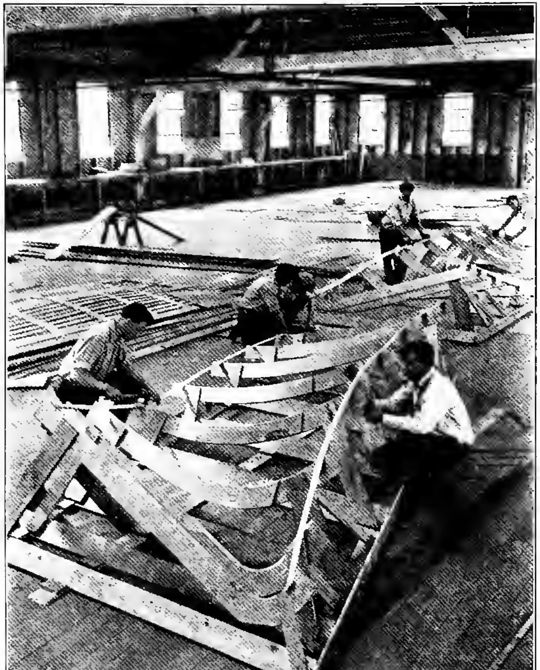
Length over all	622 feet	6 inches
Length between perpendiculars	600 feet	0 inches
Breadth, extreme	65 feet	3 inches
Depth molded to upper deck	41 feet	10 inches
Depth to boat deck	59 feet	6 inches

Engines, twin screws, ten cylinders.
Horse power, on trial, 31,000.
Speed, on trial, 23–18 knots.
Average speed per hour, 22.01 knots.
Gross tonnage, 12,950 tons.
Passenger accommodations —

First class	600
Second class	400
Third class	1,000
Crew	400
Total	2,400

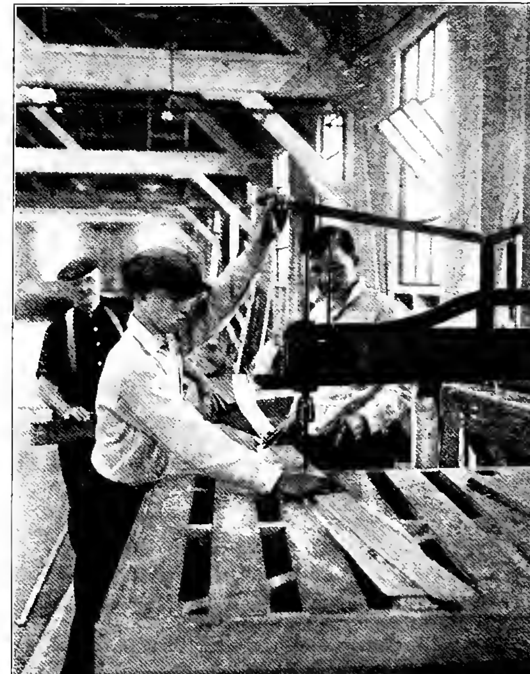
Ocean liners, special freighters, and tramp cargo ships have made up the bulk of American shipping in recent years. Liners are steamers so made as to carry passengers, or passengers and freight, or freight only. They are large and substantial, capacious ships of average speed. They are seaworthy and capable of making long voyages and carrying a considerable tonnage. They are usually employed in special lines of trade, run on schedule time, like railroad trains, and call regularly at particular ports. A large proportion of American foreign-going steamships belong to this class. The principal companies operating American lines are, the American Line, United Fruit, W. R. Grace & Co., New York and Cuba Mail, Atlantic Fruit, Munson, American and Cuban Pacific Mail, Pacific Coast, and Oceanic.

Special freighters are engaged in taking specific goods to specific ports. A large proportion of American freight



APPRENTICES BUILDING A FRAME TO INDICATE THE RIGHT CURVATURE FOR A STEEL PLATE

The chief difficulty in learning the work of the loftsman lies in becoming used to working with curved surfaces



AN APPRENTICE LEARNING TO OPERATE A POWER DRILL IN THE MOLD LOFT

The template-maker does skilled work in basswood and other light woods

ships are employed in such trade. The Standard Oil Company operates about sixty "oil tankers" which carry oil in bulk to the large ports of the world. The American-Hawaiian Steamship Company employs about twenty-five such freighters in the Hawaiian sugar trade. Several companies use such vessels, of 10,000 tons' capacity, for sending cargoes of coal from American ports to Italy, Greece, and elsewhere. At present these ships return with water ballast, so that they yield profit only on the outward journey. A large number of these vessels are now being built in American yards.

The tramp cargo boat is the most profitable of all commercial steamers. There are, however, very few of them owned in America. Over seventy-five per cent of British steamers are of this class, and the percentage of Norwegian tramps is higher even than that. The typical tramp ship carries about 4000 tons of freight and has a speed of about ten knots per hour. She is fitted to run in any climate and carry any ordinary kind of cargo. Her dimensions enable her to enter almost any port in any part of the world. These vessels start from their home ports loaded, and are kept going around the world from port to port as long as freight is to be carried; hence their character and name. Many of the American sailing ships of fifty and one hundred years ago had the same nomadic kind of trade. Sometimes the tramp ships are away from their home ports for five or six years. The British and Norwegian tramps have excelled in recent years in volume of cargo and skill of navigation. Indeed, the few American tramps now afloat are mostly under English management.

In 1870 35.6 per cent of American imports and exports by sea was carried in American commercial steamers and

the few sailing vessels that were still in use. In 1914, when the war opened, only 9.7 per cent of imports and exports was so carried. The balance, 91.3 per cent, came and went in foreign ships. The present crisis is restoring our shipping to its rightful place and service for our own country and for the world in sea traffic.

In the present war the demand for the transportation of troops has been greater than ever before in the history of the world. England has sent millions of men to France and there have been great movements of troops by water by others of the warring nations. Greatest of all has been the task imposed by the war upon our own country. Nearly two million men have already been sent to France. Another million are in our training camps, and other millions are ready for the call. All these must cross our "Bridge of Ships." Thousands of disabled men and their attendants must return in the meantime, and finally millions of soldiers and sailors will come back to enter the callings of peace.

Every available means of transportation has been called into use. Japan has aided the Allies; France and Great Britain have in turn sent transports to carry our soldiers across the Atlantic. American passenger ships, enemy ships taken in our harbors, and even battle-cruisers, have been converted into military transports.

A transport is simply a passenger vessel used for conveying military forces by water. The vessels so used must have the largest possible passenger capacity, and one of the great accomplishments of our shipbuilding has been the special form of transport now being built in our yards, a vessel of high speed and of 12,000 tons' burden. Contracts have just been let for the immediate building of ninety-two of these leviathans. Even now we can send

more than a quarter of a million men to France each month. Ninety thousand were sent in one week in July. This great fleet of the largest troop ships ever set afloat will add almost beyond measure to our power to turn the tide of the war.

When the war is over, these and other vessels now used as transports will be returned to passenger traffic and to merchant shipping.

Transports are usually convoyed by ships of war, and so carefully and efficiently has this been done by the naval forces that our losses from the beginning have been surprisingly small.

There has gradually been developed a special type of cargo vessel, as already indicated, for carrying such products as cotton, coal, rice, and grain. Size, strength, the least possible displacement, and carrying capacity are most to be desired. Speed from ten to fifteen knots will do in ordinary times. At present the yards are trying to produce speed above that of the submarine when not submerged. Shape in the cargo vessel ranges from the earlier seagoing ship to the latest tank. In the year 1909 "Lloyd's Register," which sets the standard of English ship construction, established measurements for a new type of single-deck cargo vessel as follows:

Length, 399 feet.
Width, 51 feet.
Draught, 24 feet.
Deadweight carrying capacity, 8000 tons.
Average sea speed, about ten knots.

The frames used are known as deep frames. They consist of bulb angles twelve inches deep and spaced twenty-five and one half inches apart. A single row of pillars is erected at the center line throughout the length of the

vessel. This form of ship is characterized by the absence of bulkheads and larger frame shapes at less distances than two or two and one half feet. Every piece of framing possible is dispensed with, for a minimum of weight and a maximum of strength and capacity.

In American shipyards such vessels are being constructed upon the more conservative plan of bulkhead and special framing. They also usually have several decks. The typical American and English cargo ships are shown in cross-section in the accompanying illustrations. The prevailing type being constructed in American yards has had its development since 1907.

One of the well-known methods is called the "Isherwood System." In this system of construction the transverse frames and beams are placed about twelve feet apart, thus leaving much wider intervals than are customary in other ships. The transverse frames are riveted direct to the shell plating and deck of the vessel, forming complete belts around the hull. Around their outer edges are slots which allow steel beams called "stiffeners" to be fitted lengthwise of the ship, not only on the deck, but on the sides, bottom, and tank top.

The following figures of boats building and on order at the end of each year since 1907, disclose at once the progress of this system (figures for entire world):

				Tons deadweight carrying capacity
Sept., 1907, to Dec., 1908	6	ships	aggregating	31,608
1909	36	"	"	212,992
1910	76	"	"	484,752
1911	140	"	"	958,795
1912	240	"	"	1,777,348
1913	270	"	"	1,993,034
1914	311	"	"	2,351,322
1915	468	"	"	3,548,221
1916	620	"	"	4,666,000

Fig. 1

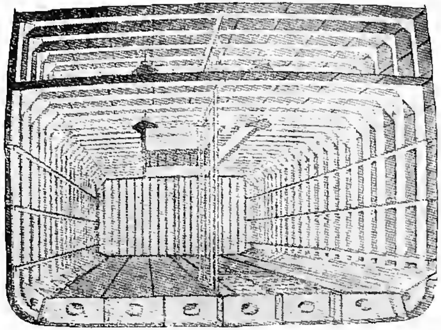


Fig. 2

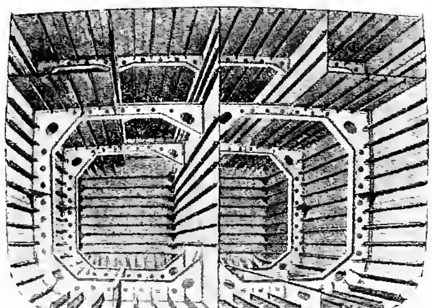
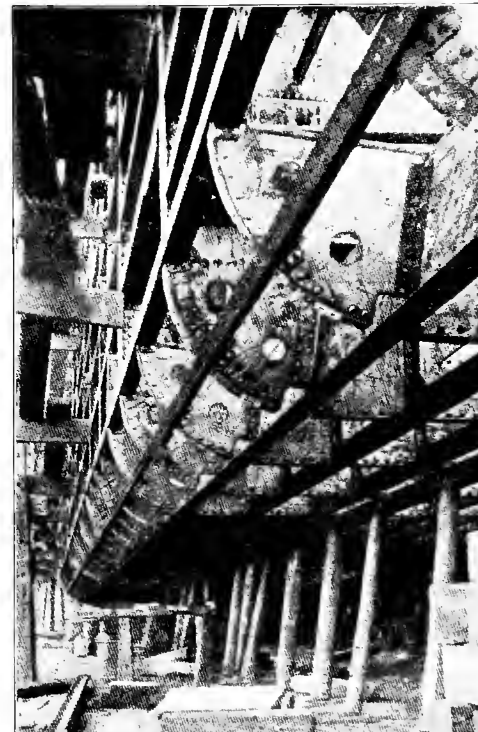


Fig. 3



CONSTRUCTION METHODS USED ON STANDARDIZED FREIGHT SHIPS

Fig. 1. A typical English plan. Fig. 2. The Isherwood System, showing the widely spaced frames and longitudinal stiffeners
Fig. 3. The notched frames used in the Isherwood System and the stiffeners between the frames and the hull plating

Following is a larger table which gives interesting information about nine typical cargo steamers which have recently been built in this country. Here appear the type of ship, its dimensions, tonnage, the gross weight of the ship itself, and the time required from keel-laying to launching.

The fabricated ship is a standardized ship, much like the standardized vessel built in England. In size it ranges from 7500 to 9300 tons' burden, a far reach from the 30-ton ship first built on the coast and from the 120-ton Mayflower of 1620. It has a low speed of sixteen or seventeen knots, but large carrying capacity.

Briefly, it is a ship on which the work of punching and shaping the plates, with some assembling and riveting, is done in a fabricating shop such as is ordinarily used for bridge or other structural steel work. It means speedy production in hull manufacture. This plan of ship construction was developed by Mr. C. P. M. Jack, consulting engineer, and Mr. Max Willemstyn, engineering manager of the Chester Shipbuilding Corporation and of the Merchant Shipbuilding Corporation, assisted by officials of the United States Steel Corporation and the American Bridge Company.

The construction of fabricated ships makes it possible to have the steel work done by specialists in fabrication, with the special tools and labor-saving devices at their disposal. It relieves the shipyard of much hard work of construction and allows it to devote its energies to erection, engineering, riveting, and the installation of outfit and equipment.

This kind of ship offers the greatest opportunity for a large increase in our tonnage. Such a ship has been built on the Great Lakes for years, for carrying great quanti-

Particulars of Cargo Vessels recently built in the United States and the Time Occupied in the Construction from Laying the Keel to the Date of Launching or Delivery

Name of ship	*Builders*	*Type*	*Dimensions*	*Deadweight tons*	*Gross weight of iron and steel tons*	*Time from laying keel to launching or delivery*
Frank H. Buck....	Union Iron Works Company, San Francisco, Cal.	Oil tanker, two decks, poop, bridge and foc'sle	410 ft. × 56 ft. × 31 ft. 8 in.	9,400	3,000	Five months and five days.
Pacific............	Union Iron Works Company, San Francisco, Cal.	Two deck general cargo vessel, with poop, bridge and foc'sle.	400 ft. × 56 ft. × 32 ft.	9,700	2,400	Three months and four days.
Gulflight..........	New York Shipbuilding Company, Camden, N.J.	Oil tanker, two decks, poop, bridge and foc'sle.	392 ft. × 51 ft. × 30 ft. 2 in.	7,300	2,620	Five months and thirteen days. Keel laid to delivery.
Orion............	Maryland Steel Company, Sparrows Point, Md.	American Government collier. Wing tanks and oil cargo and fuel tanks.	514 ft. × 65 ft. 6 in. × 39 ft. 6 in.	12,750	4,500	Five and a half months.
La Brea..........	Union Iron Works Company, San Francisco, Cal.	Oil tanker, two decks, poop, bridge and foc'sle.	435 ft. × 56 ft. × 33 ft. 6 in.	10,200	3,300	Three months and three days.
Santa Barbara....	Wm. Cramp & Sons Ship and Engine Building Company, Philadelphia, Pa.	Shelter deck general cargo vessel. Three decks, foc'sle and lower deck in fore hold.	404 ft. 6 in. × 54 ft. × 36 ft. 9 in.	9,500	2,750	Five months.
Paulsboro.........	Union Iron Works Company, San Francisco, Cal.	Oil tanker, two decks, poop, bridge and foc'sle.	435 ft. × 56 ft. × 33 ft. 6 in.	10,200	3,300	Three months and four days.
Holden Evans.....	Baltimore Dry Docks and Shipbuilding Company, Baltimore, Md.	Oil tanker, two decks, poop, bridge and foc'sle.	293 ft. × 47 ft. × 28 ft.	5,000	1,600	Three months and eighteen days.
Clement Smith....	Baltimore Dry Docks and Shipbuilding Company, Baltimore, Md.	Oil tanker, two decks, poop, bridge and foc'sle.	293 ft. × 47 ft. × 28 ft.	5,000	1,600	Three months and one day.

ties of iron ore from Lake Superior down through the canal to the steel furnaces of the East. One kind of work prevailed, and one kind of vessel was developed for that work. Shipbuilding becomes standardized, but, more important still from the viewpoint of production, machinery and the entire outfit of the ship become standardized and may be produced in large quantities in places remote from the shipyard. The Emergency Fleet Corporation has made a contract with the American International Shipbuilding Corporation to build seventy 8000-ton fabricated steel vessels designed to have a speed of fifteen knots. This is the largest single contract yet let by the Government.

There are four leading types of fabricated ships — the tanker, the shelter-deck freighter, the two-decked freighter built with sheer, and the two-decked freighter built without sheer. These types differ mainly in minor respects. Conventional ship shapes and plates are used in most part in all of them.

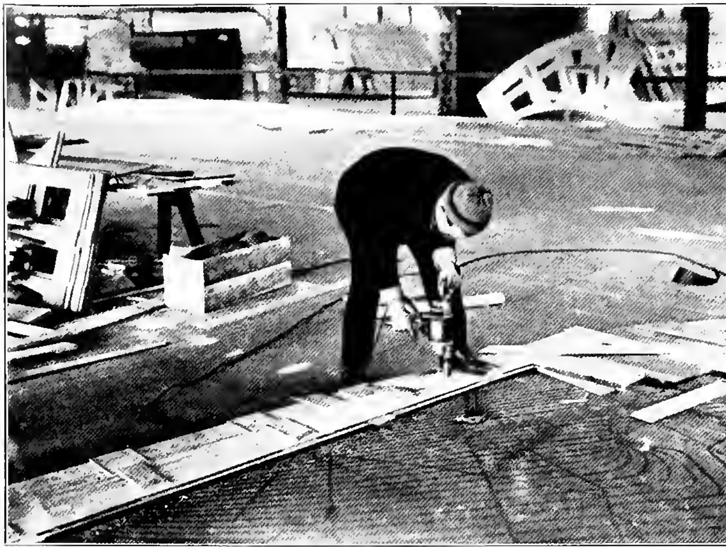
The tank ship, however, named from its system of cylindrical tanks, is of special interest. It is less liable to destruction by a torpedo, and has great carrying capacity. The modern tanker is a large box-shaped vessel with flat bottom and perpendicular sides, designed for carrying a liquid cargo, such as oil or molasses. The tonnage ranges from 5200 in those built before 1915 up to 15,000 in some of those now building. The tanker is necessarily a slow sailor, and many have been sunk by submarines.

Full standardization of tank ships is not practicable because of the various uses to which they are put and the various sizes found best for these uses. Those now building represent nineteen distinct designs and are being constructed in sixteen different yards. The Shipping Board

does not include the tank steamer in its programme, beyond those now under contract. There are, however, about one hundred and seventy now in service and sixty-four under construction in the yards.

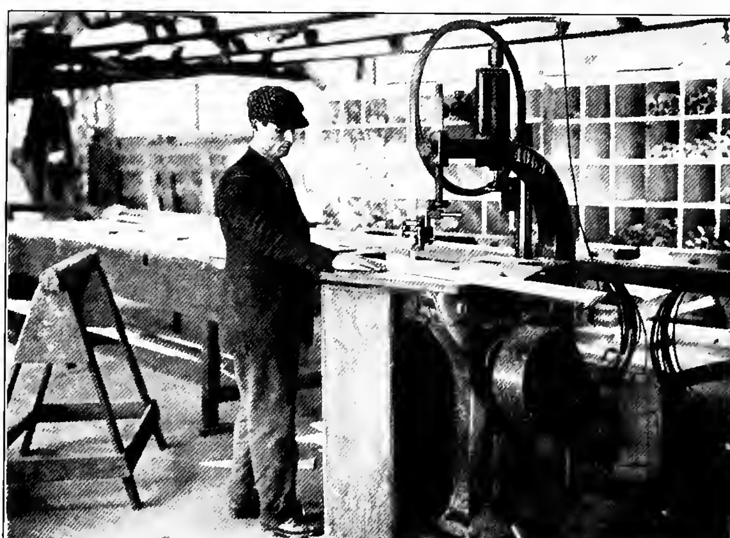
It is well known that when the Emergency Fleet Corporation undertook to build many hundreds of vessels in record-breaking time, it was found that our steel mills could not furnish the necessary material immediately, and it was, therefore, decided to build a large number of wooden ships. The fact, however, has not been so well known, or at least, has been given less consideration, that there was not sufficient seasoned lumber in the mills of the country to build the large number of wooden ships demanded. Most of the timber out of which our wooden fleet must be constructed was still standing in the forests when the vessels were ordered. Decades ago shipbuilders turned from wood to iron and steel; now they have turned from steel back to wood, and necessity, ever "the mother of invention," demanded a substitute for wood. The civil engineers of the Emergency Fleet Corporation came forward with the proposition, "Why not try reinforced concrete? Good-sized barges have already been built of this material and they have stood up well despite hard usage. Concrete can be molded readily to conform to difficult shapes and curves; it is much easier to handle in this particular than either wood or steel. Besides, concrete is extremely durable, grows stronger and harder with age, and will resist severe shocks. When damaged it can be repaired with little trouble, and quickly. And then it should be remembered that the raw materials are at hand well-nigh everywhere and in ample quantities."

It was also pointed out that if steel rods or bars and wire mesh or lathing were used for reinforcement, these



DRILLING HOLES IN A TEMPLATE WITH A PORTABLE ELECTRIC DRILL

These holes indicate the spacing for rivets



BAND-SAWING SECTIONS OF A WOODEN TEMPLATE IN THE MOLD LOFT

products could be turned out very easily by the smaller mills of the country. Because of the arguments presented in all these facts a decision was made to build one of the monolithic ships. Since that time the movement has spread in Canada and Europe, and beginnings have been made for the construction of ferro-concrete craft of many kinds, from simple barges to self-propelled ocean-going freighters.

After a long investigation of the possibilities of using concrete in marine construction, conducted by the United States Bureau of Standards and the Shipping Board, the Board on December 27, 1917, created a Department of Concrete Ship Construction. A corps of engineers has since been engaged in the development of a standard design for a reinforced concrete ship of approximately 3500 tons' deadweight cargo carrying capacity. The same designing force is also supervising the building of the few concrete ships already under construction. Contracts for such ships have been made with three yards — the Liberty Shipbuilding Company of Boston, the Fougner American Steel Concrete Shipbuilding Company of New York, and the Ferro Concrete Shipbuilding Company of New York. Other contracts have been under consideration, and for larger ships, up to 7500 tons. Five designs are under consideration, and upon the comparative success of these at an early date will depend the standard adopted for permanent use. All but the largest allow the installation of the boiler, machinery, and fittings of the Government standard wooden ships. It is planned, also, to build concrete barges for harbor and inland waterway service.

The seaworthiness of the concrete ship has been the subject of a great deal of discussion. On the one hand,

extreme skepticism has been expressed; on the other, the most extravagant claims have been made. Such ships, sometimes called "ferro-concrete," have been constructed in Norway and have proved entirely satisfactory. These have been built over an inverted wooden hull or mold, and launched bottom up. They are easily righted by means of a system of air and water compartments. It has been supposed that a ship hull made of concrete would be too rigid for service, that it would crack and give way under the stress of the ship's load and the pounding of the ocean waves. But this is not so. Reinforced concrete is elastic, if well proportioned. High tensile steel and concrete have practically the same coefficient of elasticity. Indeed, it is claimed that this fact of equal elasticity suggested the combination of steel and concrete for shipbuilding, or the construction of concrete ships.

The steel frame or reinforcement about which the newly mixed concrete is poured, in carefully prepared molds, has about the same weight and strength as the frame of the steel ship. The frame is the basis of strength in any ship. The wall built upon it, whether of steel plates, wooden planks, or a cement mixture, serves mainly to exclude the water and keep a ship afloat.

Concrete ship hulls are modeled by various processes. In some cases the hull is cast in adjustable molds; in others the steel framework is assembled, then covered with a wire or metal lathing to receive the concrete, and finally plastered, or coated, both inside and outside with the cement mixture. The cement is waterproof throughout. The latter process is more desirable, since it does not have to be renewed. The bottom of the hull is covered with an anti-fouling paint which keeps the ship free from barnacles and other marine growths, and the marine

wood-borer cannot penetrate the concrete as it does the timbers of the wooden ship.

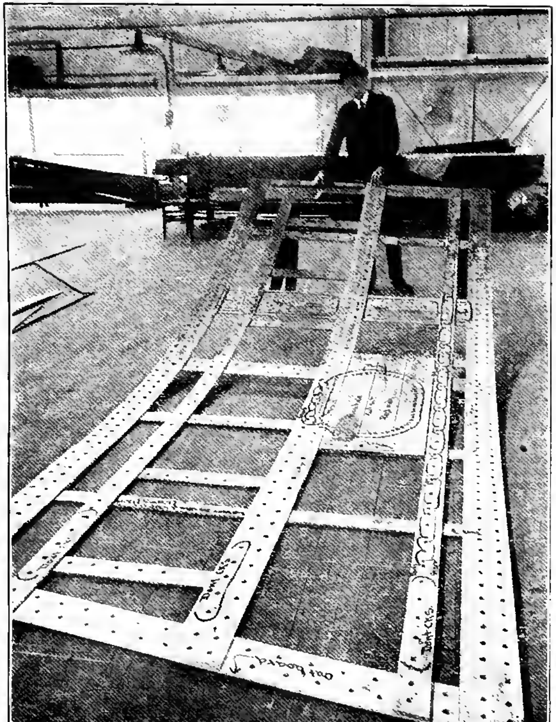
It is estimated by experts that a 5000-ton monolithic cargo ship would require $60,000 worth of reinforced concrete for its hull, while a steel freighter of the same dimensions would cost about $300,000, or five times as much. While it is difficult to estimate speed in building of concrete, with the work still experimental, it is believed that under normal conditions a concrete hull can be modeled in one half or possibly one third of the time required for building one of steel.

A most important and interesting discovery has just been announced by the Shipping Board, in July of the present year, 1918. Formerly a great difficulty in concrete construction of all forms has been the fact that concrete is porous. This has been looked upon as a serious drawback in using concrete for the ship's hull which must remain constantly in the water. Now the chief of the Concrete Ship Division states that the engineers of the division have produced a protective coating which is expected to make concrete ships as durable as steel, if not superior in resisting the action of sea water. Moreover, the division has developed a new concrete mixture which is actually one fifth lighter than wood; that is, the new concrete ship will have but four fifths the weight of a wooden ship of the same dimensions, aside from the varying weight of the frame work. This is an important item in the matter of tonnage, since the concrete vessel will be able to carry a somewhat heavier load. This new concrete mixture is so light that it floats on water, and it has also twice the strength of that used in ordinary building construction. The concrete ship is likely to compete somewhat with the wooden, and with the steel ship. New

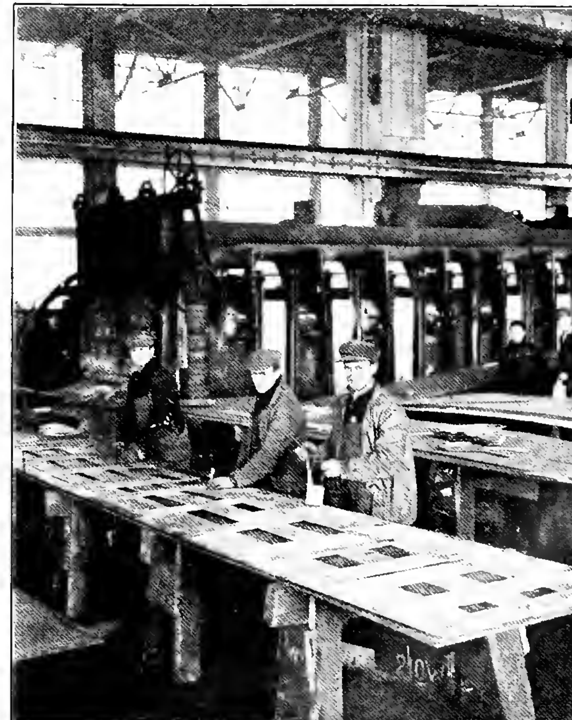
yards are being constructed for it and additional contracts are likely to be given out in the near future.

There has been proposed, under the name of the "Hunnewell hull," a combined steel and concrete ship. This gives a new type of hull, consisting of a steel middle section or body and concrete bow and stern. This method merely preserves the older methods of building the straight or comparatively straight sides of the ship body, and takes advantage of the ease of concrete construction for the curving ends. This plan is the invention of Naval Constructor F. A. Hunnewell, of the United States Coast Guard. Patents have been applied for and the plan is arousing some interest among naval constructors and shipbuilders. This combination of steel and concrete is justified, it is claimed, and a consistent and economical design is being worked out. Two distinct kinds of material and labor may be utilized at the same time, resulting in more rapid construction than the former conventional types of hull permit.

Mr. Lewis R. Ferguson, General Manager of the Liberty Shipbuilding Company, states that the labor for building concrete ships is very largely unskilled. House carpenters can be used for form work. Ship carpenters are not needed at all. The steel is fabricated and placed by a comparatively small group of men skilled in work with reinforcing steel, assisted by a large proportion of common laborers who are easily trained for the purpose. The concreting is done with unskilled labor almost entirely. In addition to economy in labor and materials it is anticipated that the concrete ship will offer further advantages. For instance, it was anticipated that the vibrations set up by the machinery would be very much reduced in concrete ships as compared with steel ships.



A FINISHED TEMPLATE FOR ONE OF THE STEEL PLATES FOR THE HULL



SHIP-FITTERS USING THE TEMPLATE TO MARK THE PLATE IN THE STEEL MILL FOR PUNCHING, SHEARING, AND BENDING

This has been borne out by the experience with the Faith, a 5000-ton ship recently launched at San Francisco. During her first trip in very rough water an almost entire absence of vibrations was reported. The cost of upkeep of concrete ships will probably be less than in the case of steel or wooden ships. The size limitations have not yet been investigated thoroughly but it is likely that these ships can be built as large as the economical management of seagoing cargo steamers requires.

Although there are many serious construction problems yet to be solved, many engineers believe that concrete shipbuilding offers a means of increasing our ocean going tonnage without drawing to any considerable extent upon the labor or materials which are needed for steel and wooden ships.

The first of steel-clad battleships was the United States ship Monitor, of Civil War fame. This small ship was the first to mount the turret which has changed the plan of the navies of the world. The turret is a fortress on shipboard. No longer is the hull pierced with row on row of loopholes for cannon. No longer is sea warfare mainly a test of the destructive power of the "broadside." A few mighty guns, equal to the usual land gun, are mounted in the turret and command all quarters of the ship, being swung easily in every direction. Turrets have increased in number, so that there may be four or more, of the revolving kind, upon a ship. And the battery of big guns is constantly increasing in number and size. They are mounted, as a rule, on the midship line. The present range of such guns is from ten to twelve miles, but plans are under way for still more powerful guns, with a probable range of twenty miles. The steel armor of the ship is constantly being made lighter, as speed is greatly to be

desired. The battleship which has the more powerful cannon and greater speed may keep her distance from an enemy ship and destroy it at long range. A heavily armored deck is now more desirable than heavy armor on the outside of the hull. The deck offers a large mark to an enemy at a distance for a shot fired at an angle up to forty-five degrees.

The first ship of the "dreadnaught" class was herself named Dreadnaught, and so excelled the battleships formerly built as to give her name to this kind of war vessel. In recent years the United States battleships have been named after the various states of the Union.

A ship of war is built for one purpose only — to fight. Everything is sacrificed to efficiency in its construction. While the ideal warship represents a combination of many desirable qualities, there are three major, indispensable requirements — flotation, motive-power, and gun-power. Flotation and motive-power mean also sailing radius and ease of handling. The battleship must remain afloat; even when considerably damaged in action, she must be capable of controlled movement in any direction, and she must be able to deliver a powerful and accurate fire against the enemy.

The boilers should be placed below the water line, with a protective deck of heavy armor over them. Some of the latest battleships, however, have their boilers in part above the water line, so as to use the greatest number possible in an effort to increase speed.

The battleships are floating fortresses, the greatest achievements of man in his mastery of the ocean. The following tables show the safest minimum armor and the maximum armor used up to the present time, and estimated for larger ships, according to Commander Yates

Stirling, Jr., U.S. Navy, in the "Scientific American," March 3, 1917:

Table of Safest Minimum Armor

Ships	*Gun-power (inches)*	*Armor (inches)*	*Speed (knots)*	*Length (feet)*	*Beam (feet)*	*Draught (feet)*	*Displacement (tons)*
1	12–14	8	26	765	88	29	30,750
2	12–14	8	29	930	89	30	39,500
3	12–14	8	32	1,135	93	32	53,500
4	12–14	8	35	1,400	100	34	80,000

Table of Maximum Armor

Ships	*Gun-power (inches)*	*Armor (inches)*	*Speed (knots)*	*Length (feet)*	*Beam (feet)*	*Draught (feet)*	*Displacement (tons)*
1	12–14	13½	21	600	97	29	32,000
2	12–14	13½	26	895	98	31	45,000
3	12–14	13½	29	1,070	100	33	59,500
4	12–14	13½	32	1,250	106	36	79,000
5	12–14	13½	35	1,500	114	40	102,000

The battle-cruiser is a war vessel built for cruising, for sailing farther and faster than is possible for the battleship. Our Navy has but few of these at the present time, and none are being built in our yards, as they do not prove to meet the needs of the present naval warfare. The demand is rather for dreadnaughts, submarines, and submarine destroyers and chasers. On the other hand, cruisers may be used as messenger ships in war and as convoy ships to troop transports or even as transports in case of need.

The principal necessary features of the cruiser are:

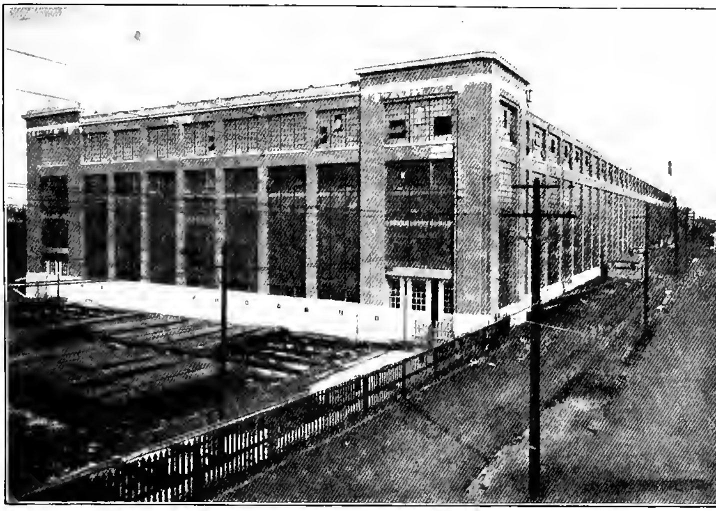
1. Seaworthiness.
2. Ability to remain at sea for long periods, which means capacity for stores and coal and habitability.
3. Speed.
4. Powers for offense and defense.

Cruisers are also divided into three kinds — armored, protected, and unprotected. The first has protective armor plate on the outside of the hull of the ship or battery; the second has no outside armor, but a thick steel deck placed at about the level of the water; the unprotected cruiser has neither special armor nor special steel deck. There are modifications, however, and combinations of these methods of building. Sometimes the terms "first class," "second class," etc., are applied to cruisers. In our Navy small ones are called "gun-boats."

In time of war fast merchant steamers are frequently armed as "auxiliary cruisers" and used as ocean scouts and fleet scouts or convoys.

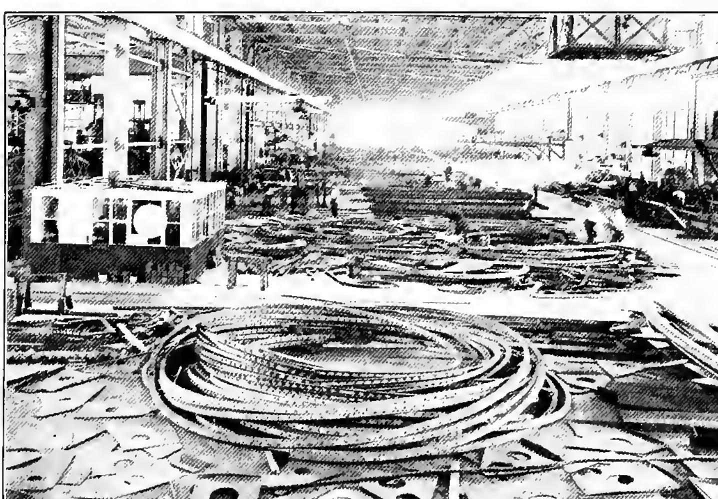
Our battle-cruisers bear the names of American cities.

The torpedo boat is a small war vessel fitted to use the torpedo as its primary weapon of offense. It carries but few and small guns. The chief requisites of such a boat are high speed, ease of handling, seaworthiness, and efficient means of launching a torpedo. The boat must be long, slender, lightly constructed, and run low in the water. The tubes from which torpedoes are discharged are hung upon pivots in the deck. The torpedo boat made for sea service varies from one hundred to two hundred and fifty tons. A smaller one is made for harbor use, varying from thirty to one hundred tons. The harbor boat has low speed, or about fifteen knots; the other has a



A PLATE AND ANGLE SHOP OR STEEL MILL

Here the plates and frames are cut to size, punched for rivets, bent into shape, and otherwise prepared for the hull. The entire upper floor of this building is occupied by a mold loft



THE FRAME HALF OF THE STEEL MILL

Here the framework of the hull is fabricated. The "shapes" in the foreground are for the hull of a submarine

speed of from twenty to thirty-five knots. The "torpedo-boat destroyer," or the "submarine destroyer," is simply a larger vessel, running from two hundred and fifty to six hundred tons. It mounts heavier guns, and is meant to prey upon the regular torpedo boat.

The torpedo boat has developed into the submarine, both the submerged and submersible types. The need now is for boats to destroy the submarine. Both American and English shipyards are producing destroyers and smaller craft to fight this, rather than the larger ships of war. When the German war fleet appears the English and American fleets can meet it with four dreadnaughts to one, but we did not at first have enough small craft to meet the undersea scourge.

The new destroyers will emphasize all the features that have given them success so far. Up to the present time thirty knots an hour has been the limit of speed at sea. The new vessels will sail thirty-five knots, or about forty-one miles — nearly the speed of an average railroad train. The fifteen-knot submarine, which is clumsy on the surface, can do little but submerge when the destroyer appears on the horizon. Not only do the destroyers have such unprecedented speed, but they are easily controlled. They can be turned abruptly about, or stopped very quickly. These new ships carry five- and six-inch guns instead of the three- and four-inch of several years ago, thus giving them a stronger armament than formerly. They draw but eight feet of water, and, with their swiftness, are almost immune from torpedo attack. The torpedo travels most successfully about fifteen feet below the surface, where it is not affected so seriously by the wave motion of the surface. The destroyer is the sentinel of the deep.

The invention of the underwater torpedo has resulted from a desire to find some means of destroying warships without being seen by the enemy. There has been the wish also to cause great loss to the enemy with small outlay in the means of producing that loss. Any small boat, therefore, that could steal near an enemy ship and discharge a torpedo could be made use of. The torpedo itself when discharged travels with remarkable accuracy for ten thousand yards, or about six miles, at a speed of from twenty to thirty-five knots.

By daylight, under normal conditions, no small boat can safely approach as near as five or six miles to a modern warship. Moreover, accuracy in hitting demands discharge at as small a distance as possible.

Battleships themselves use the torpedo tube, but ineffectively so far. In the great battle of Jutland, in which over one hundred and twenty ships were engaged, only one German torpedo hit a British vessel, the battleship Marlborough, which was struck near the stern but continued to fight. No doubt hundreds of torpedoes were discharged in this battle, the great majority being fired at random, merely toward the enemy on the chance of hitting. While the torpedo is traveling under water, the mark, an enemy ship, may be moving at equal speed straight away or to the right hand or left hand.

On the other hand, the torpedo was used so effectively by Japan, in an unexpected attack upon Port Arthur at the opening of the Russo-Japanese War, that Russia lost ships enough to give Japan control of the sea and advantage in the war.

Because of the difficulty of making the torpedo effective, the invention of the undersea boat, or submarine, has been perfected, and mainly by American genius.

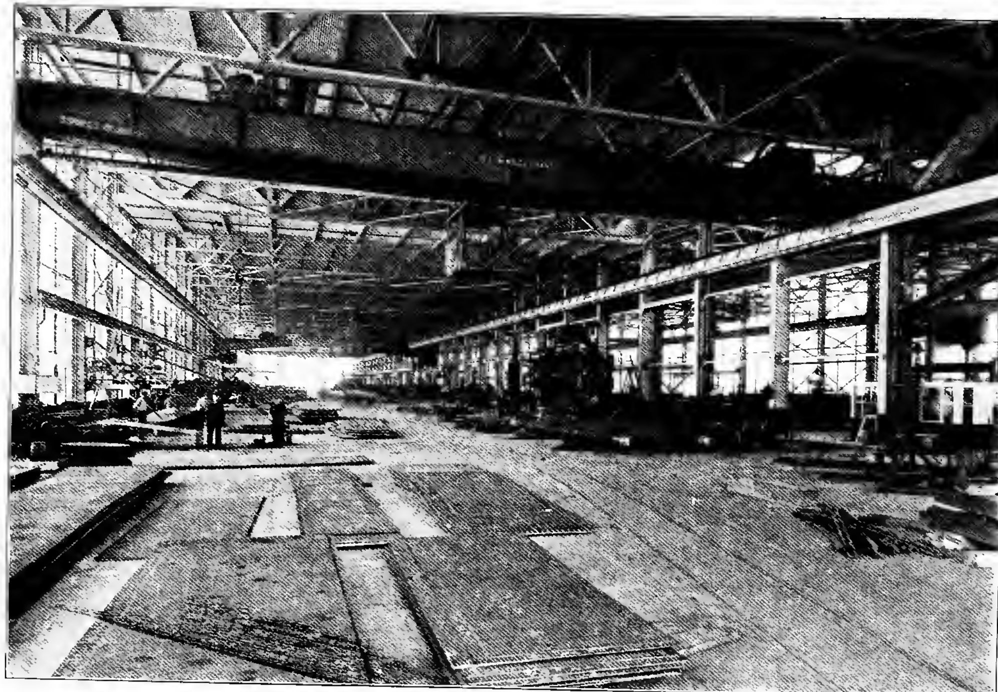
Although the submarine has only recently become of practical value in naval warfare, attempts were long ago made to construct a boat capable of sailing under water. The first such boat was built in Holland in 1624. It was merely a wooden shell decked over and covered with leather. It was large enough for one occupant only and propelled by an oar worked from within after the manner of sculling. This crude device demonstrated the practicability of undersea navigation. Yet nothing further was done until 1772, when David Bushnell, a student at Yale, invented a boat called the Turtle, varying from the first mainly in shape and driven by a screw propeller turned by hand from within. A torpedo was carried on the outside of the hull, so as to be attached to the hull of an enemy vessel, and exploded by a time mechanism. The only attempt made to use this boat resulted in failure from poor management and it became an object of ridicule. Next came Robert Fulton, inventor of the steamboat. In 1799 he laid plans for a submarine before the American naval authorities, but was put off without encouragement. He then spent three years in France trying to secure attention to his invention. Finally Napoleon Bonaparte became interested and caused the appropriation of ten thousand francs for construction and experimentation. Fulton then built the Nautilus, which failed because of the lack of any other means of propulsion than hand-power. Fulton took his plan to England, where William Pitt at once grasped the significance of the idea of a boat that would annihilate the naval power of nations. The British Admiralty, however, refused to encourage a device that other nations might develop to the destruction of England's naval supremacy. They offered to buy the invention, so as to control it, but Ful-

ton would not sell. He returned to the United States in discouragement, and thereafter devoted all his energies to the development of the steamboat. It is safe to say that the country and the world then needed the steamboat far more than the submarine.

Nothing more was done for sixty years, until during the Civil War the Confederate authorities constructed a number of small steel undersea boats called "Davids." These were propelled by steam engines. They carried torpedoes fixed to the ends of spars. The purpose was to ram an enemy vessel under water. Only one such attack was made, however, and that on the Federal gunboat Housatonic. The resulting explosion destroyed both the Housatonic and the "David" attacking.

In 1863 Le Plongeur, the first large submarine ever built, with a displacement of nearly five hundred tons, was constructed in France. This boat failed because compressed-air engineering was still undeveloped, and no suitable means of stability under water had yet been devised. The French Government abandoned the experiment in 1874.

Mr. John P. Holland, an Irishman in this country, whose name is now attached to the submarine, next took up the problem, planning a boat to be used against England's fleet in a proposed Fenian revolt. The revolt did not materialize, but the submarine did. The automobile torpedo and the electric storage battery were later perfected, thus making a workable and effective submarine possible. In 1890 Holland built the first one to meet the requirements set by the United States Navy Department. This was called the Holland, and is now to be seen at Annapolis, out of service. Its length is fifty-three feet; beam, ten feet; displacement, seventy-four tons. Rapid



THE PLATE SIDE OF THE STEEL MILL SHOWN AT PAGE 82
The overhead Niles crane carries material up to 15 tons in weight the entire length of the building

development of the submarine has followed in this and other countries to the present crisis in which it becomes the leading factor in a world war.

The submarine is the latest form of warship, except for the small boats designed for its destruction. It is a small, cigar-shaped, or fish-shaped boat. The upper surface is entirely closed over with a small railed deck and hatches that may be opened when the boat is floating upon the surface. There is a small conning tower or superstructure for observation, and a periscope for observation when submerged. The submarine usually mounts a small, quick-firing gun for use when the boat is not submerged. Its destructive fighting equipment, however, is the torpedo tube, from which it discharges torpedoes at an enemy ship at as close a range as possible. The submarine is equipped with chambers which may be filled with water when the boat is about to submerge, and from which the water may be discharged when it is about to rise to the surface. When submerged the submarine displaces a volume of water almost exactly equal to its own weight. Increasing or diminishing the total weight of the craft causes it to sink or to rise to the surface.

A typical submarine has recently been completed at Quincy, Massachusetts, for the Spanish Government. This boat represents one of the best forms produced in our shipyards up to the present time. It is about two hundred feet long and has about eight hundred tons displacement. Its surface speed is fifteen knots and its submerged speed ten and one half knots. It is equipped with two six hundred-horse power engines of the latest type. Its armament consists of four torpedo tubes mounted in the bow, and one three-inch rapid-fire gun which is so mounted that it can be used against surface craft or air-

craft. The crew sleeps in bunks which can be folded back into the sides of the hull when not in use, and comfortable quarters for the officers are provided in the bow. This boat is named the Isaac Peral, in honor of the naval officer of that name who completed the first practical submarine for Spain in 1887. His early boat was seventy feet long, eight feet and six inches in beam, and had a displacement of eighty-seven tons.

Submarine requirements are strength, so as not to be collapsible when submerged to considerable depths, and ease of control. Some of the latest are provided with a net-cutting apparatus at the bow, so as to pass through the nets placed by the enemy.

The submarine freighter is not a remote possibility, to carry merchandise through danger zones in war-time, and to escape the danger of storms at sea. The practicability of such a merchant ship has been shown by the German Deutschland.

For this purpose, as well as for active warfare, it has become desirable to construct a larger boat, capable of cruising long distances from the base of supplies and strong enough to withstand the greatest underwater pressure. A type lately designed is the "multitubular diving boat" or "seagoing submersible," having the following characteristics:

Length over all	229 ft. 6 in.
Maximum breadth	27 ft. 11 in.
Draught in surface full-load condition	13 ft. 2 in.
Surface speed	23 knots
Submerged speed	8¾ knots
Radius of action at 23 knots	2000 miles
Radius of action at 18 knots	2900 miles
Radius of action at 16 knots	3200 miles
Surface displacement	1200 tons
Submerged displacement	1595 tons

This boat is propelled when upon the surface by four motors having 7400 horse power, and when submerged by an electric motor of 1200 horse power.

No striking features differentiate the existing types of submarines and submersibles which are now in use or under construction. It is largely a matter of power and cruising radius, as indicated above.

Designs have been proposed for a standardized boat, for surface use mainly, but with power to submerge upon need, of from 5000 to 10,000 tons' capacity. This design would permit the use of standard steel shapes and plates of full size for over eighty per cent of the hull construction. A large number of gangs could be employed at one time on a hull, and ordinary steel workers, riveters, or laborers could be easily trained for the work. Equipment is less than in the ordinary ship. Such a ship could be completed in from sixty to ninety days.

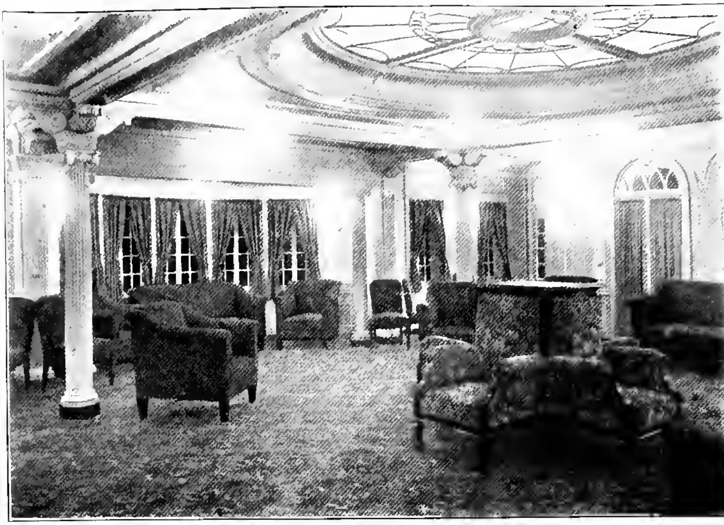
In any one of our yards, that is properly equipped with the ways, shops, and materials to do the work, forty of these boats could be under construction at one time. The cost of building is not great, nor is the time required long. The Allies are on the defensive in sea warfare, however, being compelled rather to meet the menace of the submarine by using all forms of war-craft possible to fight it, by arming merchant ships, by designing new forms of boats or adapting motor boats to sea fighting, and by the use of nets, airplanes, deep-sea bombs, and other means which are continually being devised.

On the other hand, it is supposed that Germany, after the disastrous defeat of her battle fleet at Jutland, turned all the resources of her shipyards to submarine construction, as her only hope upon the sea or of winning the war at all. Germany staked all upon unrestricted submarine

warfare — and is fighting a losing contest. Formerly all nations agreed upon the inviolability of commerce and passenger ships. The German U-boat has warred upon all floating craft, with the avowed intention of terrorizing her adversaries. Through her ruthless submarine campaign Germany voluntarily ranged America as the ally of her enemies.

At the opening of the war there was no adequate means of combating the submarine, except by use of the somewhat large torpedo boat destroyers. The first American warships to take part in the present war were destroyers in a flotilla which began operations off the coast of Ireland early in 1917. It would cost too much to produce destroyers in great quantity, and other means of fighting the submarine have been sought. The aeroplane and hydroplane have been employed for defense and observation along the coast lines, and have proved especially useful. They make it possible to observe a submerged boat. The aeroplane may even drop deep-sea bombs upon the undersea boat. Yet it has been realized that the brunt of the work to be done must be done by surface craft. Therefore the small, high-power boat has been brought into use.

Motor boats have been requisitioned, and are proving, perhaps, the best means of solving the problem. If the motor boat can hit the periscope of the submarine the latter is rendered harmless when under water, and is not likely to rise to fight. Early in 1915 Russia gave an order for 36 motor boats of high power. These boats were 60 feet long, had a V-shaped bottom, and 3 engines yielding 600 horse power. They had a speed of 30 statute miles, and carried a 3-pound gun amidship and a machine gun forward. Immediately England ordered 550 motor



THE OBSERVATION ROOM AND THE FIRST-CLASS SMOKER ON THE S.S. GREAT NORTHERN

Designed by Harry B. Etter, of Philadelphia

Only a few first-class passenger steamers have been built in American yards, so the interior decorators' trade has been neglected. The construction of freight and troop ships calls for very little work of this kind

boats, 50 of a 75-foot design and 500 of 80 feet in length — "five miles of motor boats."

Fifty of these boats would cost only as much as one torpedo boat destroyer and could be produced in as short a time. England built the 550 boats in 550 days. In 1916 our own Navy Department began the construction of such boats, at a cost of from $12,000 to $38,000 each. Our shipbuilders are now producing such craft in increasing numbers, varying from mosquito fleets of "40-footers" to motor boats of 100 feet or more in length and capable of long sea voyages. The submarine "swatter" must be very fast and easily controlled. It must be seaworthy and provide comfortable quarters for the crew. Speed is attained up to 40 miles an hour.

At the great Ford shipyard at Detroit little vessels, or motor boats, called "eagles," are being produced at the rate of about one a day. The assembling plan used so successfully in automobile construction is applied to the building of these boats. The raw material in the form of frames and plates enters one end of the plant and emerges at the other end as a completed fighting craft. Each of the little vessels is passed along from one group of workmen to another, and as it passes each group adds something to the boat. When the last rivet has been driven in the steel hull, the boat is picked up bodily by a powerful hydraulic lift and deposited farther down the ways, where skilled workmen install the motor equipment. The boat is then placed in the water without ceremony or artificial adornment, a veritable greyhound of the deep. The work of this yard furnishes a most interesting and typical example of the power of American skill and organization in meeting the greatest problem of the war.

Preceding the present war our country had an expand-

ing period of plenty and luxury in home life and in travel by land and water. The stern demands of the war, however, are changing our customs and ideals in every feature of the home, in every line of commerce, and in every regulation and condition of travel. This fact has its effect in the ships now being built. Simplicity and economy are the watchwords. But in the ships already afloat the old order still prevails.

The great passenger steamers, ocean liners, coastwise passenger vessels, steamers in passenger service on our thousand lakes and rivers, yachts and other pleasure craft, have been fitted out with every comfort and luxury, every device for beauty and adornment. Indeed, the great steamers and liners are veritable floating palaces. The best class of passenger ships are fitted out with the most skillful work in wood and in interior decoration. The richest woods of the globe are sought and used, as in the palatial hotels of our large cities. Every possible effect is sought in wall, ceiling, paneling, and finishing, in hangings and in coloring. Beautiful and luxurious parlors, dining-saloons, smoking-rooms, writing-rooms, promenade-decks, observation-rooms, and other facilities for the use of passengers are provided. Merchant ships have excellent and commodious living-quarters. Ships of war have every provision in equipment necessary for health and general welfare, but sacrifice all else for efficiency in action.

CHAPTER IV

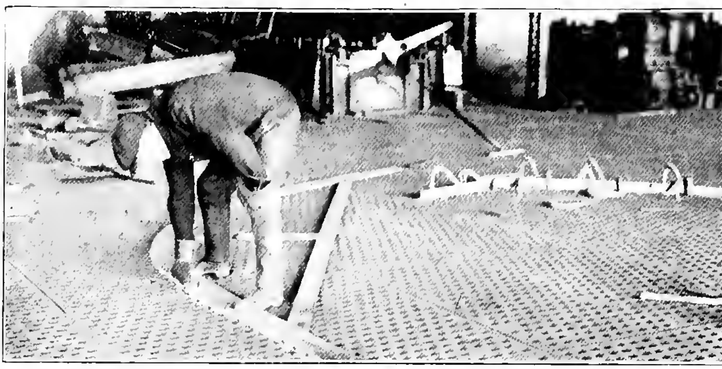
FROM THE BLUE-PRINT TO THE FINISHED SHIP: A GLIMPSE OF A MODERN STEEL SHIPYARD

ON the 5th of May, 1915, a medal was struck in Germany which anticipated by two days the sinking of the Lusitania. Exactly two years later Chairman Hurley of the United States Shipping Board announced to a group of workmen in a Delaware shipyard that they were each to receive a medal commemorating the launching of the Tuckahoe. America had answered Germany's challenge by creating a shipbuilding organization which established a new world's record when it launched a 5500-ton steel collier twenty-seven days after the keel blocks were laid. The sinister emblem distributed in Germany typified the spirit of destruction. The silver medal presented to the workmen of the New York Shipbuilding Corporation expressed a very different motive. The speeches of the Government officials, Mr. Schwab, Mr. Piez, and Mr. Hurley, the cheers of the crowd as they watched the steel hull glide down the launching ways, all rang with the true spirit of the builder. They realized that the Tuckahoe was no mere spectacular effort staged for advertising purposes. Instead, she represented the culmination of American industrial organization and coöperative effort in a constructive programme. Aside from placing and connecting her engines and machinery, she was practically a completed vessel. Ten days later she was to be delivered to the United States Government, and on the fortieth day from the laying of the keel

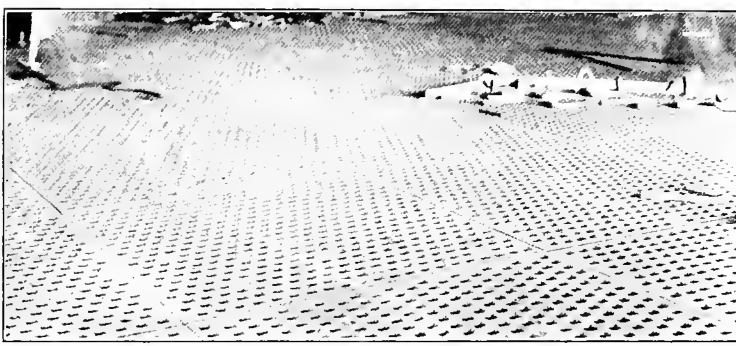
she was to steam out of Hampton Roads with a full cargo on board. Such an accomplishment is the finest possible expression of an immense organization whose staff is dominated by a common loyalty, a common enthusiasm.

It must not be supposed, of course, that a production plant so highly and efficiently organized as the Camden yard which built the Tuckahoe could grow up from nothing in a few months. The present organization was built upon an older company whose efficiency and capacity have merely been intensified and enlarged during a year and a half of emergency construction. In many respects shipbuilding offers one of the most interesting examples of industrial organization to be found anywhere. The large number of trades involved, the immense quantity and the great variety of materials used, the highly technical character of the plans and specifications necessary for rapid and yet economic construction, combine to make it difficult to organize the work or to standardize its methods.

Many of the newer yards have greatly simplified the problems of construction by building so-called "fabricated" ships. Material for these ships is prepared at steel mills and factories in various parts of the country, thus leaving only the work of erecting the hull and placing and connecting the machinery to be done in the shipyard. The crux of the problem involved in this method is well expressed by an answer made by a foreman to George J. Baldwin, Chairman of the New York Shipbuilding Corporation, while he was making a tour of the Camden shipyard. He saw plates, angles, and forgings being punched for rivet-holes, cut to size, and shaped in the shops. "How often do you have to return any of this material to the shops to be refitted or reshaped?" he



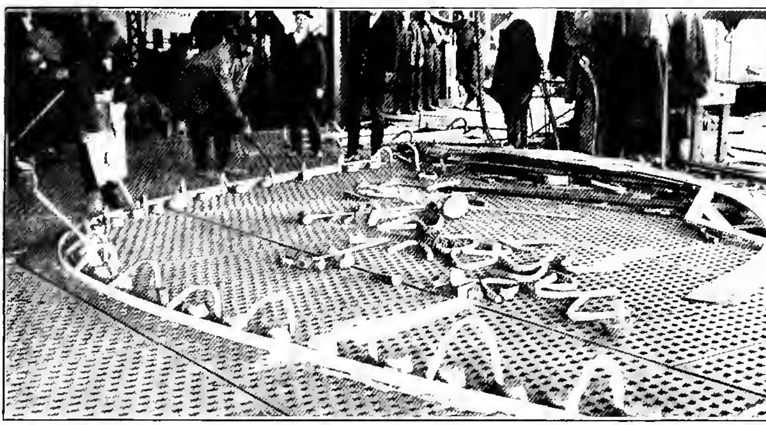
Marking the line on the "slab," or working floor, of the furnace shed



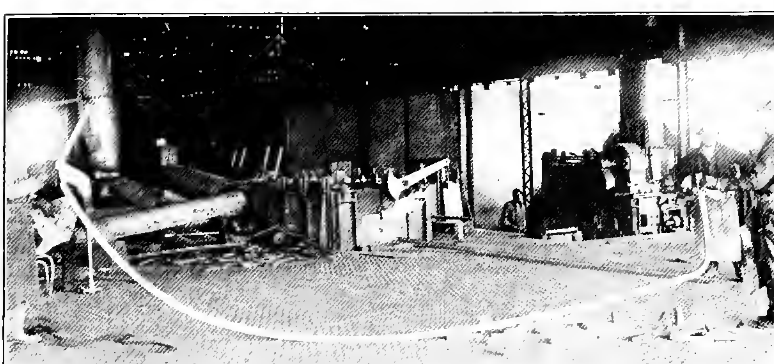
The line on the "slab" which shows how the "shape" is to be bent

The steel "shape" being carried into the furnace shed

Drawing the heated "shape" from the furnace



Hammering the bar into the right form on the "slab"



The finished "shape"

G OF A "SHAPE" FOR THE HULL OF A SHIP

asked the foreman. "Never," was the reply. "Mr. Baldwin, when we shape a piece of steel here, it fits."

Even in the yards building fabricated ships, where the number of shops and mills is greatly reduced, an extensive plant is required. The following description gives one a glimpse of the conditions at Hog Island, near Philadelphia, one of the largest of the yards following the fabrication plan:

On September 22, 1917, the American International Shipbuilding Corporation started work at Hog Island. The place at that time was a vast swamp of bottomless mud. To-day the morass has become a city of some 30,000 population containing the largest shipyard the world has ever seen. For a solid mile along the Delaware fifty shipways stretch like a line of gigantic fortifications. Back of this vast array of ways, street upon street in ordered series, is built the city — for Hog Island is nothing less than a populous new city. At one of the principal street intersections, officers stand throughout every hour of the twenty-four regulating the endless stream of heavy traffic. A magnificent guard of some six hundred trained soldiers under the leadership of Major Sinclair, a veteran of the present war, keeps order and polices the works. A fine band, worthy to rank with many a famous musical aggregation, furnishes music at all hours of the day, for there is always something going on at Hog Island, where music is an appropriate adjunct.

You will find in this magic city hospital accommodations which would do credit to any community, presided over by Dr. Reiley, one of the most brilliant men in his profession. Here also, almost complete, is a great industrial Y.M.C.A., with an auditorium capable of seating 2000 persons and equipped with games-room, gymnasium, class- and study-rooms.

A filtration plant of the most modern construction furnishes the city with pure water. A complete system of sewerage insures proper sanitary conditions. There are warehouses miles in length, crammed with material assembled for the fabrica-

tion of ships. Half a dozen compressed-air plants send their power to all parts where construction is in progress. A first-class hotel, a railroad station, a fire department worthy of any city, post-offices, electric lighting, and all the physical conveniences which make city life attractive are here. More than seventy-five miles of railroad penetrate to every part of the island, and to each one of the fifty shipways.

In the construction of this city and shipyard, there have been used more than 80,000 wood and 5000 concrete piles. Nearly 12,000,000 cubic feet of lumber and 12,000 of concrete have gone into the shipways. There are seven 1000-foot outfitting piers in process of completion — more 1000-foot piers than exist to-day in the port of New York after 250 years of development.[1]

The Hog Island yard was constructed by the American International Shipbuilding Corporation in association with the engineering firm of Stone & Webster for a fixed fee of approximately 3.3 per cent of the total amount expended. For the first 120 boats and the erection of the plant the aggregate estimate is $200,500,000. Mr. George J. Baldwin, Vice-President of the American International Corporation, in an address before the Philadelphia Chamber of Commerce gave an excellent description of the new methods to be used in this and other yards building fabricated ships:

"The problem was to produce the greatest number of first-class steel ships in the shortest time. They were to be cargo ships of ample carrying capacity and satisfactory speed. They could not be built in any of the already overburdened existing yards. Entirely new methods of shipbuilding must be employed never before used, but none of these things must be experimental. In answer to this problem three entirely new ideas stood out:

[1] Charles Aubrey Eaton, "Delaware River Shipyards — A Modern Miracle," *Review of Reviews*, July, 1918.

"1. A design so radically simplified and standardized that every succeeding vessel would be an exact reproduction of the first, identical in every detail, thus eliminating every possible variation in size and shape of material.

"2. The plan required the mobilization throughout the entire country of the largest proportion possible of all resources germane to shipbuilding and the adaptation of these resources to the new purpose. This included first and foremost the bridge and structural steel industries, then the builders of engines and boilers, the forges and machine shops and factories capable of producing any pieces of equipment entering into a ship, from a propeller shaft to a sextant. New organizations could not be thrown together, nor new plants built, to do this work; nor could it all be brought to the shipyard, as the output must be secured from thoroughly organized shops of long experience.

"3. The reproduction of vessels in large numbers, every one of exactly the same construction, permitted the use of the factory methods in which America is preëminent. The new shipyard was to become the assembling floor of a colossal ship factory, whose machinery was made up of all the inter-related wheels of American industry, whose employees were a large part of the entire body of American labor, and whose conveyor belts were the American railways.

"This solution, both in method and in magnitude, was a new departure in shipbuilding. Standardization had been attained to a slight extent in England, but on nothing like the scale demanded by the present programme. It required the consolidated and coördinated effort of scores of the largest, strongest and most efficient corpora-

tions in the United States and could not be accomplished in any other way.

"The 'fabricated' idea simply means that you have a 'manufactured' ship instead of a 'made-to-order' ship, just as we have 'manufactured' automobiles instead of 'made-to-order' ones.

"All non-essentials have been suppressed. Curvature of plates, especially those requiring multiple bending, were as far as possible eliminated. Ordinary structural steel beams were substituted for special ship shapes. The fabricated ship has no camber of the decks, but they are flat, like those of a battleship; no sheer, but a straight deck line from bow to stern, perpendicular sides and a flat bottom; a strictly rectangular midships section, only curving on the bilges; a design of boat carefully combining the best ship- and bridge-builders' practice with that of our most efficient manufacturers. Maximum cargo space was adjusted to maximum safety, utilizing a multiplicity of bulkheads, which have saved more than one torpedoed oil tanker from going to the bottom. This designing has been so accurately and carefully done that the model tested in the Government testing tank shows a speed as great and requires as little power as the average vessel turned out in our best shipyard practice.

"In the conventional shipyard each vessel is designed, and the specifications are prepared in accordance with the client's desires. The steel and iron required in the form of plates, shapes, angles, etc., and all other materials are delivered from the mills to the shipyard where the plates are shaped and punched, the frames bent, punched, and beveled, the riveting done, the stern posts and connecting rods forged, the pumps, boilers, and engines built; in fact, every component part of the vessel is worked out

to a special design, so that each boat stands unique as an individual piece of workmanship, made such by a trained force of skilled shipbuilders.

"America had standardized the construction of machine tools, making them better and cheaper than any other nation. It has standardized its agricultural machinery and supplied Europe, South America, Asia, and Africa. It is preëminent among nations in manufacturing standardized, simplified machinery in wholesale quantities, and in place of the 'made-to-order' individual ship we have simply substituted the manufacture of ships in wholesale quantities, something which no private concern has hitherto dared to experiment with on account of the vast amount of money required and the difficulty of selling or utilizing the product. No other opportunity has ever arisen under which such construction could be undertaken before the present emergency forced it upon us."

Hog Island, in common with other yards operating on the fabrication plan, is not able to do away entirely with its plate and angle shops, or steel mills, where the shell plating and frames are cut to size, bent into shape, and punched for riveting. The rolling mills are not always able to supply materials just at the time nor in the sequence required by the yards. To guard against long delays, as well as to prepare frames and plates which cannot conveniently be prepared at a distance from the yard on account of their complicated design, all of these plants are equipped with complete steel mills. The Merchant Shipyard at Bristol, for example, estimates that about 495 tons of the 2975 tons of steel required on each ship are fabricated in their own plate and angle shops.

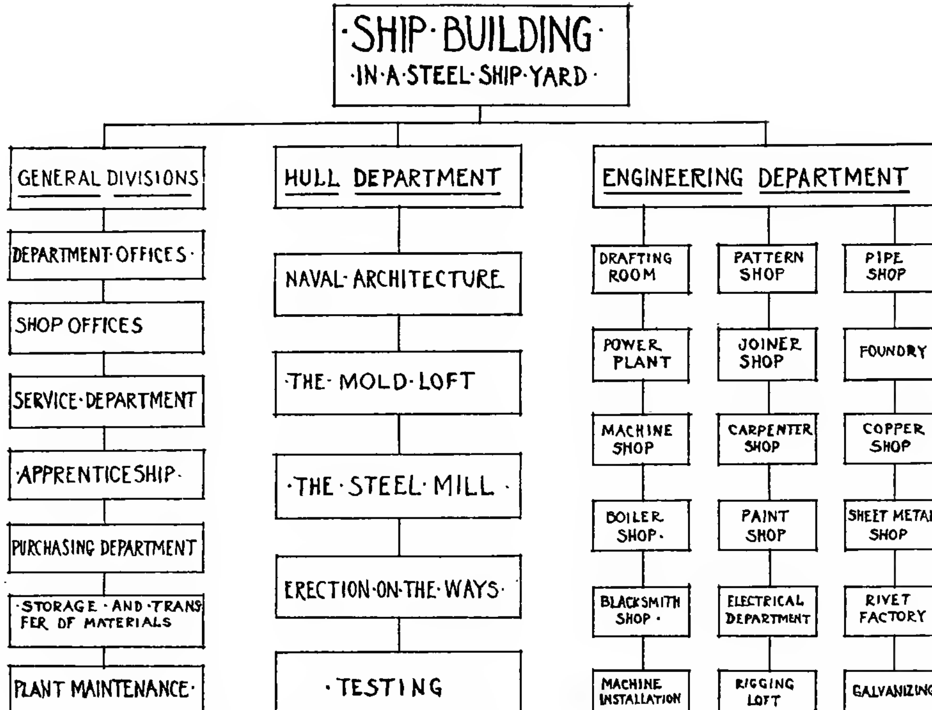
To give some idea of the extent and nature of the work

carried on in the older type of yard, which prepares or fabricates practically all of its own steel, the following description is offered of a shipbuilding plant employing about ten thousand persons. Naturally, no two of the yards are quite alike, but an account of any one of them will give a fair conception of what is found in every yard.

A shipyard is really a fair-sized community devoted to a single purpose. Like every well-regulated community, it must have an effective form of government. The executive in the plant who represents the owners is the superintendent or general manager. With the help of his corps of assistants in the main office, he must direct and supervise a great army of employees. He plans the work of eighteen or twenty shops and factories scattered over more than a hundred acres of land and manages an extensive railroad and transportation system. He is responsible for the purchase of thousands of tons of steel and other materials and for the completion of all contracts taken by the yard.

In the main offices are the officers, clerks, and stenographers of the company who are needed to do the immense amount of executive and clerical work connected with such a large concern. They purchase supplies, keep account of costs, hire new employees, and keep the records of wages and time of service. In the same building are the drafting-rooms, where the plans are drawn for the ships and for their equipment of engines and machines.

Inside the yard, we find ourselves in the midst of active operations. On one hand are the long yards and racks where are stored the plates and other forms of structural steel for the construction of the ships. On the other side are sheds piled high with lumber to be used for scaffolding and keel blocks, and for the pattern and joiner shops.



THE ORGANIZATION OF THE WORK IN A STEEL SHIP YARD

Freight trains are carrying completed parts from the mills and shops to ships on the ways or at the docks. Engine hoists and traveling cranes are lifting steel plates and girders from the yard and transporting them to the steel shops to be made ready for their places on the hulls.

Every corner of the great yard is filled with the din produced by more than a hundred gangs of riveters. From the boiler factory, the forge shops, and the steel mill comes the constant clang of heavy hammers.

From the drafting-room near the main offices the completed blue-prints for the hull of a ship go to the mold loft. Here we find a great room where full-size plans for each part are laid out on the floor. From them wooden molds or templates are made by which the ship-fitters mark each piece of steel. Their marks indicate how the steel must be cut or punched or hammered into shape, and also show where each part belongs on the ship.

Other plans go from the drafting-rooms to the shop where patterns for castings are made for the foundry, others to the joiner shop where furniture and pilot houses are built, and still others to the electrical department, the machine shops, the rigging loft, or the pipe shop to indicate how a great variety of equipment is to be built and installed on the ship.

All of the activity of the yard converges toward the ships under construction. One is likely to find them in every stage of progress from the first laying of the keel to the completed hull that has been launched and towed to the dock where the engines, boilers, and other machinery are to be installed.

The central work of the yard is the erection or construction of the ship upon the ways. Structural parts have been prepared in the steel mill, and machinery and other

parts in the various shops of the yard. As many smaller parts of the body of the ship as it is possible to assemble before putting them in place, have been brought together in or near the steel mill, or are now assembled alongside the ways or berth in which the ship is to be built.

Shipwrights, or carpenters, prepare the berth and keep it in order until after the launching of the ship. They are usually assisted by yard-riggers and bolters. The shipwrights first lay keel blocks down the middle of the ways on a slope suitable for launching. Later they place side blocks under portions of the ship where extra weight is to be sustained, and carry stagings up the sides as work progresses on the hull of the ship. A central line is run along the keel blocks to determine the place of the keel, which is brought from the steel mill in sections and marked with a central line. This flat-plate keel is laid upon the blocks so that the marked lines correspond, and butt straps are bolted on to fasten together the connecting ends of the keel sections. Then a "vertical" keel is erected upon the first one, and all parts are bolted firmly in place. Ship erectors now put in place one part after another, making all ready for the bolters, riveters, and other workmen who are to follow.

After the laying of the keel a bulkhead "head" or frame is set up across the middle of the keel as a beginning of the erection of the hull. Other bulkhead frames are erected at spaces of forty or fifty feet on each side of the first, so that work may proceed on both the bow and the stern of the hull at the same time. Between the bulkhead frames are placed other frames or "ribs" of the ship. All these frame portions, and later shell plates and other parts, are brought into place by overhead cranes. These cranes pick up the parts, carry them along and hold them

in place until they can be fitted into exact position by the erectors and bolted up. The sheets of shell plate, or "strakes," are bolted upon the outer framework of the hull and upon the deck girders at the same time. Riveting proceeds constantly while the plates are being put in place and calking, or making water-tight, follows. In the meantime machine parts are being installed in the hull by workers from the machine shops of the yard.

About one fifth of all the workers in the average shipyard are engaged in the erection of the ship upon the ways. Those who take part in the construction of the hull may be grouped as follows:

1. Shipwrights, or carpenters
2. Erectors
3. Fitters
4. Reamers
5. Bolters
6. Riveters
7. Calkers
8. Water-testers

The work of each of these trades is described in greater detail in the following sections of the book.

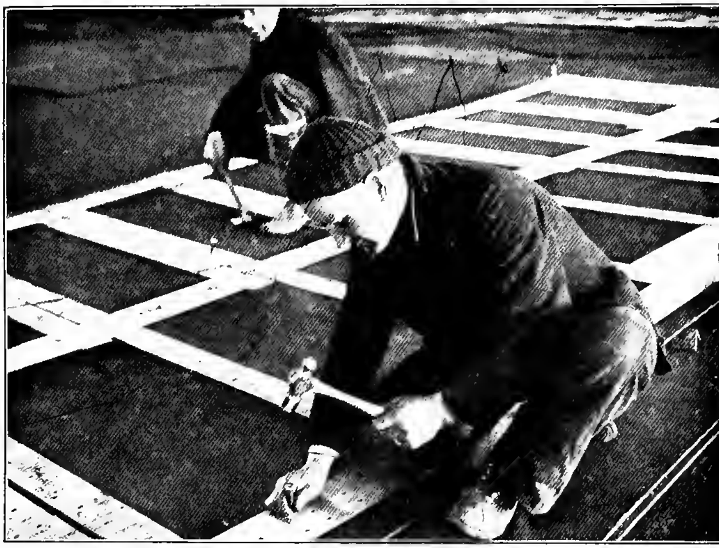
Part of the ship's machinery is installed and some of the work of the coppersmiths, electricians, painters, and carpenters is done before launching takes place. In the main, however, such operations as the installation of boilers and engines, running pipe-lines for water and steam, electric wiring, the fitting of masts, booms, and smokestacks, and the work of the joiners and carpenters on decks, pilot houses, and cabins, are performed at the outfitting pier or "wet basin." These operations take less time than the construction of the hull and fewer berths are needed at the piers than there are shipways in the yard. When completed, each of the seven great piers at Hog Island will accommodate four ships, two being drawn up on each side and served by the traveling cranes mounted on the wharf.

CHAPTER V

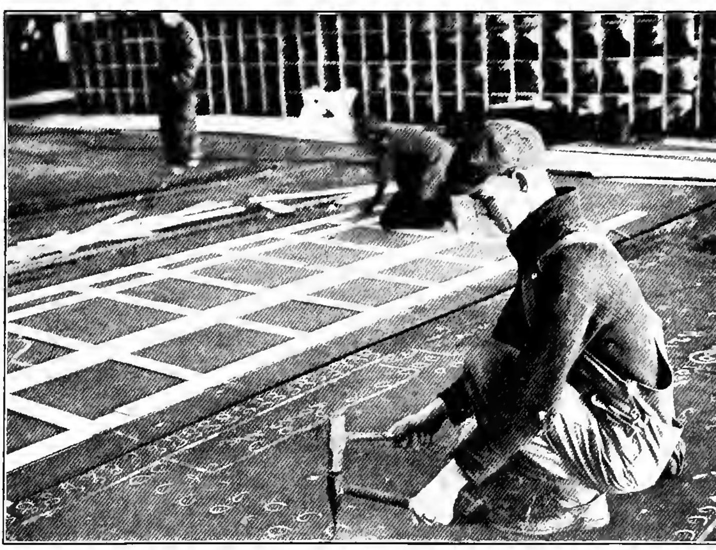
NAVAL ARCHITECTURE AND MARINE ENGINEERING

SHIPS originally were built without any plans at all. Men set up the framing timbers, one after another, by the eye, fastened them firmly in place and covered the outside with thin timbers or planks. No drawings were made, no such "acres of blue-prints" as are required at the present day. There was a long development of this primitive shipbuilding, parallel with the development of house-building, and the early shipwright worked without plans or drawings. In a later time, even down to the beginning of the nineteenth century, small models of ships, a few feet long, were carefully constructed out of wood. The small parts of these were reproduced in actual size by means of a few simple drawings. Many such models, from which numerous ships were built in colonial days, are now preserved in our naval museums. The naval architect came into being in the days of extensive wooden ship construction before the general use of iron and steel.

The construction of a ship is both an architectural problem like the building of a house, and an engineering problem like the erection and equipment of a modern office building. In a small shipyard the two kinds of work may be done by a single small department, under either a naval architect or a marine engineer. Another term in common use is "marine architect," and in the Navy the term "naval constructor" is used. In a large yard the two divisions of work are carried on in close association.



A SHIP-FITTER MARKING HULL PLATES WITH A STEEL PUNCH WHICH JUST FITS THE HOLES IN THE WOODEN MOLD



ENLARGING THE MARKS MADE BY THE WORKMAN SHOWN ABOVE

Besides simple tasks of this kind, the ship-fitters must design and make templates for complicated parts of the hull for which no drawings have been supplied. The work requires as much skill and intelligence as any found in the yard

Strictly, the naval architect is a person skilled in drafting plans for hull construction, and the marine engineer is one trained in the making of plans and drawings for the machinery and fittings of the ship. The line between the two great divisions of actual shipbuilding, the hull division and the engineering division, shown in the chart on page 208, begins in the drafting-room of this great double department. In large yards the estimating work which is necessary in connection with drafting is treated as a third division.

The work of this department of shipbuilding is to make the designs and plans of a ship and its machinery and fittings and draft and blue-print them. These blue-print drawings serve as guides for every division of the work throughout the yard. They are graphic letters of instruction to workmen.

A few of the yards have no separate drafting department, depending entirely upon Government plans or blue-prints sent from a central office maintained by the company. Even in these yards a few draftsmen are required to develop working drawings for the various shops.

Preceding the drafting of the plans and the preparation of the blue-prints which are to be used in the actual construction of a ship, comes the work of drawing up the general design and the specifications used in ordering materials. Designs may be worked out in the drafting department, under the naval architect, or plans and specifications may be submitted to a shipyard with an order for building received from some outside source. At the present time the shipyards are building ships for the Government upon standardized designs which have been worked out by naval architects and engineers employed

by the Emergency Fleet Corporation or by the shipyards and navy yards. These men have the highest professional education and training. Some of them maintain private offices as consulting naval architects. They study the best types of ships built in this and other countries, and adopt designs or develop new and advanced ones. The actual drawing of a design is usually done by ordinary draftsmen employed in their offices.

A ship design may be worked out quickly or it may be the result of long investigation and study. The bulk of the work of the department, however, has to do with drafting, which may be divided into hull drafting and engineering drafting following the great divisions of the work of the yard as already indicated. These are closely inter-related.

The hull drafting department deals with plans for building the body of the ship. There are usually four leading departments or divisions in hull drafting, with a man in charge of each, as follows:

1. Structural drafting.
2. Ventilation drafting.
3. Hull pipe drafting.
4. Hull engineering drafting.

These divisions have to do with the making of drawings for the structure, ventilation system, piping system, and engineering features of the hull.

Designing, when done in the department, constitutes a fifth division which precedes the four given above.

From the specifications of a design drawings are made to scale for all parts of a ship from the keel to the decks, deck houses, and superstructure. Several blue-prints are made of each of these drawings so that they may be sent in duplicate or triplicate to all the departments or divi-

sions of the yard, such as mold loft, steel mill, joiner shop, or paint shop. One copy of each drawing is kept in the department as a record, and the foreman on every job has a copy.

The estimating division reckons costs, draws up new designs, makes calculations for launchings, and for capacity and general strength. Estimating calls for much more ability than does structural drafting. In drafting, a good memory and drafting ability are most important, while making estimates calls for originality and much higher mathematical training.

The staff of workers down through the hull department in a typical yard is as follows:

1. Naval architect.
2. Chief hull draftsman.
3. Assistant hull draftsman.
4. Four leading draftsmen.
5. Draftsmen.
6. Tracers.
7. Apprentices.
8. Stenographer.
9. Clerk.
10. Messengers.
11. Head man in blue-print room.
12. Helpers, men, and boys in blue-print room.

The best entrance to ship drafting is through apprenticeship in the yard, since it gives one a knowledge of the various parts of a ship and of the steps in ship construction. Draftsmen trained in technical schools or courses make rapid advancement after they become familiar with ship work and ship terms. The apprentice coming up through the line usually becomes an expert draftsman in two years' time.

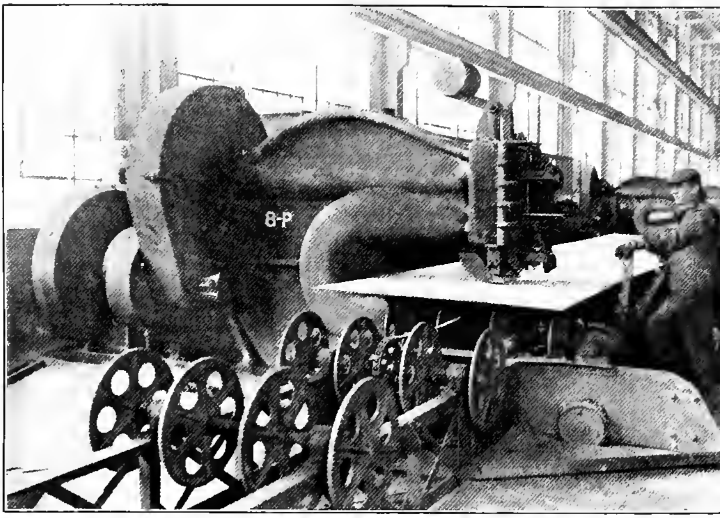
Those who enter this work may be divided into three classes: First, boys with little or no training, who may begin as messengers, or office assistants, or pass through apprenticeship classes; second, men with college preparation; and third, draftsmen from kindred trades.

There are many grades of the work in drafting which require little or no experience. It is quite possible to arrange the different parts of the work in such a way that beginners who have had no previous experience in drafting can be allowed to do certain parts of it. Tracing represents one of the simplest tasks assigned. The untrained person may be taken into the department as a clerk or as a helper on simple pieces of work. He may next become a tracer of drawings, and by taking the training given in the yard he may become a draftsman.

It makes very little difference what line a man has followed as a draftsman, in or out of the yard, provided he has a thorough understanding of his work, and a skillful use of the ordinary drawing implements. Many men have been taken away from the drafting-rooms to take charge of other departments, or to fill important positions in other plants, thus creating a large demand for experienced draftsmen.

The draftsman is much helped by having a working knowledge of arithmetic, simple processes in algebra, and some knowledge of geometry and trigonometry, but these requirements are not always insisted upon.

The naval architect must be a high-school or college man who has taken extensive courses in naval architecture and who has had fifteen or more years' experience in a yard, coming up from the position of draftsman. There is greater opportunity than ever before for the naval architect trained in this country.



A NEW PLATE-PUNCHING MACHINE OPERATED BY ONE MAN
Used in the plate and angle shop of the Fore River Yard, Quincy, Mass.

The naval architect usually employs the workers in his department.

Applicants for apprenticeship usually apply in person; persons from architects' offices, or those having experience to offer, usually apply by letter.

The engineering drafting department is the department which deals with all plans and drawings having to do with machinery and ship-fittings. The draftsmen in this department are really engineers, frequently brought in from outside industries. They have a thorough knowledge of engines; training in drafting is supplementary to their other training. The best of them are mechanics and could do or direct any work in the yard having to do with machinery.

They usually obtain their general knowledge of machinery in a machine shop, and their knowledge of drafting in night schools or classes. Sometimes the engineering draftsman leaves the shop to attend day courses, and comes back to the shop again. On the other hand, the office boy may be trained in night courses and work gradually into the occupation while serving the company. This is rare, however, because of the high demands of this particular division of drafting.

Many ship-fittings, engine and boiler parts, and other machines and parts of various kinds are manufactured complete in the shipyards. It is quite impossible to handle the plans for these mechanical details without adequate knowledge of shop methods. Thus, for example, in designing work which must be done in the blacksmith shop, such as drop forgings, it is necessary to draw the plans in such a way as to permit the parts to be manufactured in the most efficient manner on up-to-date machinery. On this account it is quite necessary that the

engineering draftsman be quite familiar with modern shop practice.

The leading kinds of drawing in engineering drafting deal with the following:

1. Main engine; boilers, with equipment of water piping, smokestacks, and uptakes.
2. Shafting and propellers.
3. Auxiliary machinery; such as pumps, condensers, feeders, and evaporators.

All this work is of the most detailed kind; every pin or screw must be accounted for in the drawing, and great care is needed in checking all work, as a single error may throw out an entire plan.

The persons who carry on the work in engineering drafting may be classified as follows:

1. Chief engineer.
2. Chief draftsman.
3. Head or leading draftsmen of divisions.
4. Draftsmen.
5. Computers.
6. Apprentices.
7. Tracers.
8. Stenographer.
9. Messengers.

The engineering draftsmen may be called on for duties throughout the yard. Tests of special machinery are made before a final design is adopted, and technical reports on all such machinery must be made to the engineering department. When new vessels undergo trial to see whether they meet the specifications under which they have been built, draftsmen are detailed to calibrate the instruments used and to see that all machine conditions are ready for inspection by the Trial Board.

They also take readings and observations on the trials made.

In some yards girls are employed as tracers in this department, and women are now eligible as workers in ship drafting.

The computers are experts who figure only on new ideas and plans before they are given to draftsmen to lay out on paper. They must have the highest training and usually come from the colleges or technical schools.

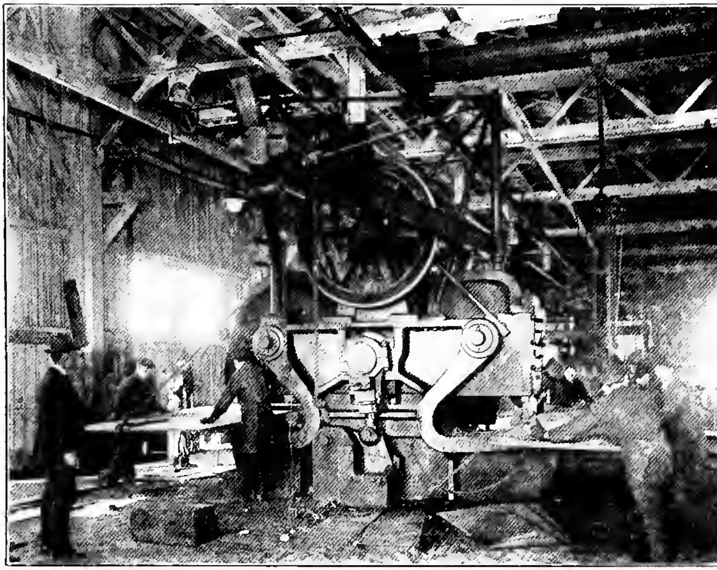
Blue-printing is done in a special room in connection with the department of naval architecture. The man in charge of the blue-print room needs no special technical training, but must have had extended experience in this kind of work. His helpers may be drawn from any source. The work consists in operating the blue-print machine, in immersing the prints in a water bath or an acid bath, and in drying them on a machine. In some yards the work is all done on one machine.

Most large yards have apprentice schools and classes in which boys and young men may learn drafting in connection with actual practice in shipyard work. In addition to these courses, some yards conduct a course in naval architecture for older persons who aim to become "leading men." In this course men employed in the department study the elementary principles of naval construction and learn the terms employed. Many of those who take these courses are college-trained men and the others have a good general education. They receive practical instruction that will be a direct benefit to them in the work they are doing.

Extended and thorough courses in naval architecture and marine engineering are given in two great institutions in this country, the Massachusetts Institute of

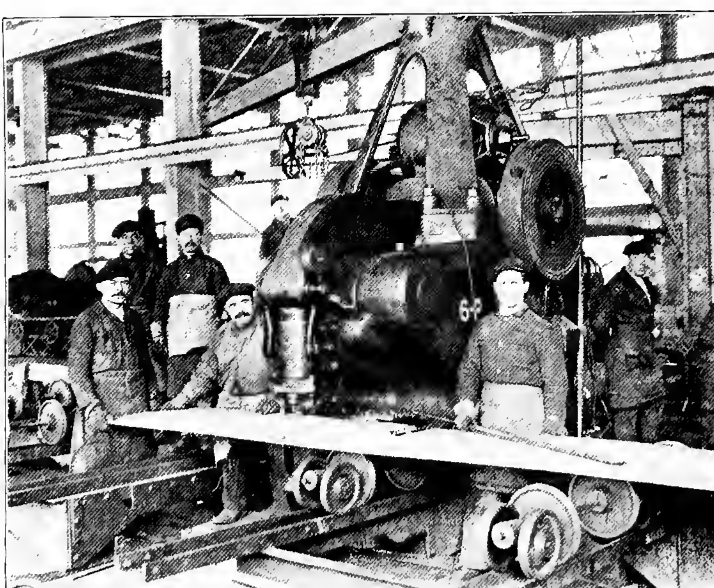
Technology and the University of Michigan. Less advanced courses, dealing more especially with ship drafting, are given by Webb Academy, a philanthropic school for naval draftsmen, in New York City, and by several high schools in shipbuilding localities. In most of these courses work in engineering is subordinated to that in architecture; that is, naval architecture is looked upon as the all-important subject. The instruction offered in the two great institutions mentioned above is intended for those who expect to be ship-designers, shipbuilders, ship-managers, naval architects and naval constructors, or marine engine builders, or who desire to enter the great allied industries, such as the steel mills or factories manufacturing shipyard equipment. The advanced courses deal with naval architecture, the theory and practice of ship design, shipyard practice, ship construction, ship ventilation and drainage, ship drawing, marine engineering, marine engine design, meteorology, mold loft work, model-making, and aëronautics.

Following is the general course given in naval architecture and marine engineering at the Massachusetts Institute of Technology. A special course, dealing particularly with warship design, is given for naval constructors, whose work is to be in the navy yards. The general course runs through the second, third, and fourth years of undergraduate work; the special course goes through the junior and senior years and adds a year of graduate study. Special short courses are now being planned which will prepare men for this work in much less time than was formerly considered necessary. It is not likely that these short courses will be continued beyond the period of the war crisis.



PUNCHING RIVET-HOLES

One of the older forms of punching-machine. The plates are supported by an overhead crane



A MODERN TYPE OF PUNCHING-MACHINE REQUIRING ONLY A FEW MEN TO HANDLE THE PLATES

Courses in Naval Architecture and Marine Engineering

Second Year

First Term

	Hours [1]
Mechanism	45–75
Mechanical Engineering Drawing	75– 0
Descriptive Geometry	45– 0
Forging	30– 0
Mathematics	45–90
Physics	90–75
Physical Laboratory	30–30
Applied Chemistry	15–15
English	30–30

Second Term

	Hours [1]
Ship Construction	20–20
Ship Drawing	30– 0
Mechanism	20–40
Mechanical Engineering Drawing and Surveying Instruments	30– 0
Applied Mechanics	45–85
Forging	30– 0
Mathematics	45–90
Physics	75–60
Physical Laboratory	30–20
Precision of Measurements	10–10
English	30–30

Third Year

First Term

	Hours [1]
Naval Architecture	30–60
Ship Design	75– 0
Heat Engineering: Thermodynamics	30–60
Applied Mechanics	45–90
Mathematics	45–90
History II	30–30
Political Economy	45–45
General Studies	45

Second Term

	Hours [1]
Naval Architecture	30– 55
Ship Construction	20– 20
Ship Design	90– 0
Heat Engineering	60–120
Engineering Laboratory	20– 5
Applied Mechanics	30– 60
Physical Metallurgy	15– 15
Foundry	45– 0
Vise and Bench Work	30– 0
Business Law	15– 15
General Studies	75

Fourth Year

First Term

	Hours [1]
Naval Architecture	30–60
Ship Design	80
Model-making	25– 0
Ventilation and Drainage	30–30
Applied Mechanics	45–90
Testing Materials Laboratory	20–10
Hydraulics	15–30
Engineering Laboratory	60–30
Elements of Electrical Engineering	30–30
Elec. Engineering Laboratory	30–30
Machine-tool Work	45– 0

Second Term

	Hours [1]
Naval Architecture	15–30
Ship Design	120– 0
Marine Engineering	30–60
Marine Engine Design	90– 0
Marine Steam Turbines	30–60
Engineering Laboratory	60–30
Sanitary Science and Public Health	15– 0
Machine-tool Work	60– 0
Thesis	120

[1] The figures in the first column of hours indicate the total number of hours devoted to class exercise and those in the second column the amount devoted to outside preparation for a term of fifteen weeks.

The following schedule of courses in marine engineering is that of the San Pedro High School, Los Angeles, California:

MARINE ENGINEERING

		Units
First Year	English	5
	Shop Mathematics	5
	Mechanical Drawing	10
	Wood Shop	10
	Music or Oral English	2
	Physical Training	2
Second Year	English	5
	Engineering Mathematics	5
	Mechanics	5
	Machine or Wood Shop	8
	Mechanical Drawing	8
	Music or Oral English	2
	Physical Training	2
Third Year	Laboratory Engineering	7
	Elementary Nautical Science, Naval Architecture, or Marine Engineering	5
	Machine Shop and Pattern Making	9
	Machine or Hull Design	10
	Music or Oral English	2
	Physical Training	2
Fourth Year	Laboratory Engineering	7
	Electricity	5
	Marine Engineering, Naval Architecture, or Navigation	5
	Machine or Hull Design	10
	Machine Shop and Pattern Making	8

CHAPTER VI

THE CONSTRUCTION OF THE HULL

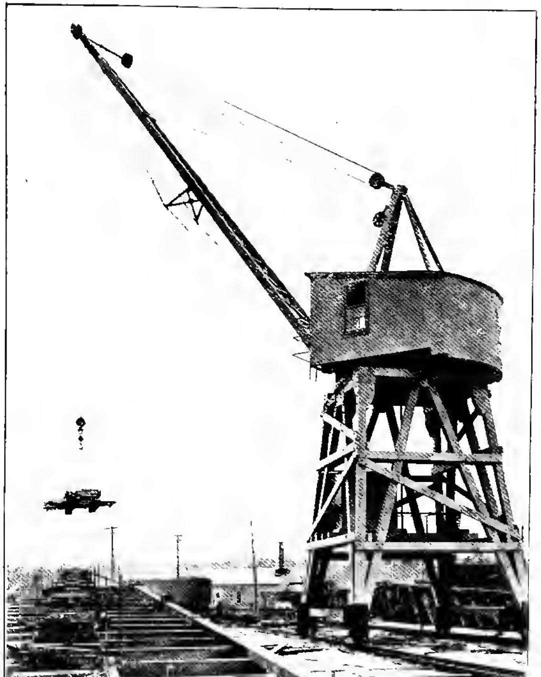
THE construction of the hull or body of the ship takes place upon the ways of the shipyard close to the water where launching will be easy. The necessity of building a vessel at the water's edge accounts for the fact that the shipyards are located along the coast and upon river-banks. These sites in most cases would be comparatively worthless for other uses than shipbuilding and often entail great expense in the driving of piles, laying foundations, and filling in and grading. Some of the smaller yards have but a few ways or berths each; the larger ones, such as Fore River at Quincy, Massachusetts, Hog Island at Philadelphia, the Submarine Boat Corporation at Newark, New Jersey, and several on the Pacific Coast, have from ten to fifty ways each.

At the present time, when the winning of the war depends upon the building of ships, it is the purpose of the Emergency Fleet Corporation to have every yard working at its capacity. Approximately, then, over 800 ships are now being built in the 826 ways of our shipyards. Adding those under way in the navy yards there are probably nearly 1000 ships under construction in the country at the present time (August, 1918). It is easy, then, to imagine how busy every yard must be when work is being carried on in all of its ways. Where twenty or thirty or fifty ships are under construction in a single yard at the same time there is demand for an endless number of drawings, blue-prints, and patterns; for

thousands of tons of steel frames and plates; hundreds of thousands of feet of lumber; numberless auxiliary parts, fittings, and machinery; and for thousands of workers both skilled and unskilled.

Before the keel is laid the material to be built upon it must be selected and prepared, or "fabricated," to use the term common in shipbuilding. The blue-prints that have been prepared by the department of naval architecture are taken from the drafting-room to the mold loft. The other plans, which have to do with engineering, or the machinery and fittings of the ship, go to the various shops of the yard where such parts are prepared. The work of all the shops supplements the construction of the hull on the ways and its finishing when launched. The following sections of this chapter will consider the duties of the employees who have some part in this construction work, which is really the central task of the yard.

The mold loft is the room in which ship plans, in blueprint form, are laid out in the actual size of the ship which is to be built. The loft usually occupies the top floor of the largest building in a yard. It may be one hundred or more feet wide and as much as six hundred feet long. It may be large enough to take the entire plan of a great passenger liner or battleship. When smaller ships are being constructed in a yard plans for several are frequently laid out in the loft at the same time, and if standard designs are being used patterns are produced in duplicate. Some yards have small mold lofts as well as one large one, so that plans for parts of ships may be handled at the same time that work is going on in the main loft. The loft has an especially prepared, smooth floor of wood, upon which patterns are expanded and marked



LAYING KEEL BLOCKS WITH A TOWER WHIRLER

The upper platform can be rotated in a complete circle, and the boom is 75 feet long, making it possible to place material on the ships under construction on either side of the track

AN ERECTING GANG

The foreman directs a group of workmen who bolt the frames and plates together as the crane swings them into position

out with extreme care, so that the parts of even the largest ship, after fabrication, will fit together perfectly.

The work of the mold loft is to make molds or "templates," as they are called in the yard, of heavy paper and of thin wooden boards, from drawings or blue-prints for all the structural parts of a ship.

A template for a steel plate consists of a full-size pattern of the plate, marked out and showing in detail all punched or counter-sunk holes, and scarfs, bends, and angle lines. In making templates some yards use paper extensively. This has some disadvantages, as the paper contracts or expands so much that it is sometimes necessary to make many corrections on the ship. Templates of basswood or white pine are better, and can be easily stored.

The shipbuilding company has a schedule of dates for laying the keels of ships. The mold loft receives these schedules and the drawings for the parts of each ship from the hull drafting department. First a "line plan," or plan for line work, is drawn up. From this is laid out upon the floor a full-size working body plan for the ship. Eight or ten plans may be on the floor at one time. These plans include the structural portions of the ship body, such as the outer shell, decks, inner bottoms, and bulkheads. All measurements and details for body plans for the guidance of loft work are found upon the blue-prints or drawings supplied to the loft. Each pattern laid out upon the floor is checked up by the blue-print specifications. Then the template-maker constructs the paper or wooden patterns or templates from the lines which have been drawn upon the floor.

The division of workers in the mold loft is as follows:

1. Loftsman, or foreman mold loftsman.

2. Assistant loftsman.
3. Loftsmen, or linesmen.
4. Template makers.
5. Apprentices.
6. Helpers.
7. Man in charge of templates.

The drawing of lines upon the floor to scale is the central and most important part of loft work. The "loftsman" is the distinctive name of the person who does this work. He must be one who thoroughly understands blueprint reading and who can do a first-class structural job in the loft. In many yards he is called a "linesman."

At the present time it is impossible to get the necessary number of loftsmen in the various shipyards. Shipbuilding in this country has not formerly been extensive enough to train a large number of these men, and actual training in the yard is necessary to produce them. Instruction is now being provided under the direction of the Emergency Fleet Corporation. The usual entrance to the occupation has been through apprenticeship in the yard. The ship-fitter may become a good loftsman and is sometimes transferred to the loft. The ship carpenter, pattern-maker, or joiner may become a loftsman.

A second distinct feature of mold loft work is the making of molds or templates. Except on small jobs men in the mold loft work in groups or gangs, named after the more important parts of the ship. Thus the "framing gang" makes molds for all framing parts, and the "deck gang" makes deck templates.

The making of molds from the lines on the floor is skilled work in wood. It may be done by an ordinary carpenter, but calls for great carefulness and exactness. There is little opportunity for unskilled men in the mold loft.

For mold loft work, in some yards, untrained boys or men are taken only as helpers; other yards use many men who have had experience in mechanical drafting, steel construction work, house carpentering, or cabinet-making. Much of the ship, such as bulkheads and decks, may be represented on a flat surface. Drawings for these parts are similar to those made for any structural work. In some cases beams are bent in order to allow for the curvature of the decks, but there is no special difficulty attached to making the templates for them.

For all of this flat work men with ordinary experience can be readily utilized. A few men are, of course, necessary who can see the work as a whole and assign the simpler portions to men from other trades or to helpers and beginners.

The work must be done upon one's knees on the floor on a very extensive scale, with absolutely correct measurements, and men used to working under ordinary conditions find it difficult at first.

Apprentices are frequently sons or acquaintances of loftsmen, ship carpenters, fitters, or other employees of the yard. The first year they are largely engaged in running errands and keeping the loft clean. The second year they start as helpers in a gang. The third year they begin to run lines and lay down small jobs, until, becoming more experienced, they are rated as loftsmen.

The service of the loftsman, the chief worker in the loft, is very important in the shipbuilding industry, is thoroughly appreciated and well paid, and must be done without haste. The person who comes into it through apprenticeship, or who enters otherwise and remains beyond the first stages of experience, is usually well satisfied with his occupation and successful in it.

The following courses have been outlined for war-emergency training for shipyard workers. The last section of the outline deals with the special subjects studied by those who are prepared for work in the loft:

Fundamental Courses for Shipyard Workers of all Classes

Yard Organization

1. The national programme for shipbuilding.
2. The relation of the yard to this programme.
3. The departments of the yard and their location.
4. Specific work of each department.
5. The relation of these departments to each other.
6. The heads of these departments and location of their offices.
7. Routing of work.
8. Requisitions, time cards, orders, reports, etc.

Names of Different Parts of a Ship

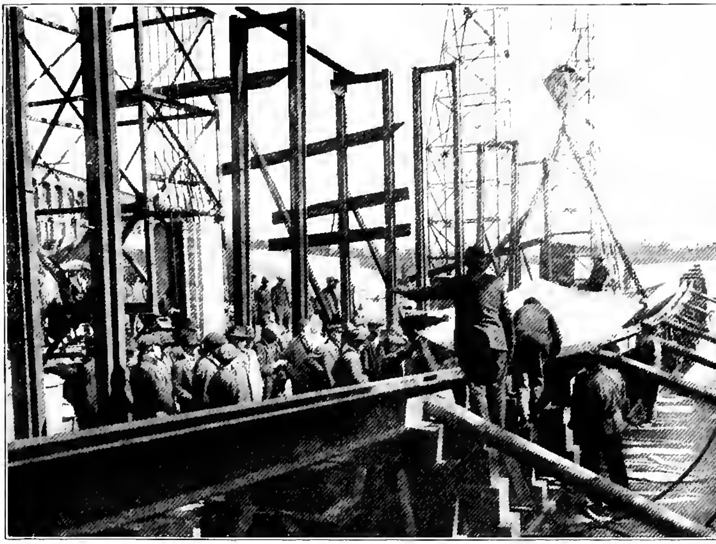
1. Profile and deck plans of a ship.
2. Midship section of ship.

This course should deal only with the most important points in ship construction and the names of the most important parts and locations, such as —

a. Main deck.
b. Boat deck.
c. Deck house.
d. After hold.
e. Forward hold.
f. Stern frame.
g. Rudder.
h. Propeller.
i. Bow.
j. Stern.

More detail may be given in (2) than in (1). The course is not a course in reading blue-prints.

A glossary of ship terms in pamphlet or mimeograph form would be an excellent text, and should be put into the hands of every student.



AN ERECTING GANG LAYING THE FIRST PLATE ON THE SPANISH SUBMARINE ISAAC PERAL

BOLTING UP

Following the erecting gang come the plate-setters, or "regulators," who bolt all the parts securely together. The bolter-up puts in enough bolts to hold the frames and plates together for riveting

Suggested Topics for Supplementary Courses for Ship Trades of the First Class

Mold loftsmen

1. Reading and interpretation of blue-prints with special reference to —
   a. Name, form, location, construction, and use of different parts of a ship.
   b. Ship terms and abbreviations.
   c. Determination of details not specified on the print.
2. Template marking.
3. Lloyd's Rules.
4. Interpretation and use of offset tables.
5. Drawing of sheer, half-breadth, and body plans.
6. Development and lay-out of special plates and shapes.

The amount of material to be used in constructing a ship is determined by the drafting department, and the specifications for materials to be used are marked upon the templates and upon cards prepared in the mold loft. From these cards an order clerk calls for the stock necessary for the work which is to be done in the steel mill.

The steel yard, or "plate yard," as it is frequently called, is a large space set apart in the shipyard for the storage of steel plates and frame bars. These materials, with their exact dimensions marked upon them, are bought from the manufacturing steel mills by the purchasing department of the yard.

The workers in the steel yard have charge of material in storage, and select and bring it to the steel mill upon the requisition of the clerk. Following is a list of these workers:

1. The man in charge of the steel yard.
2. Checkers, for checking up materials.
3. Unskilled men, or laborers, to handle materials.

ANALYSIS OF THE MOLD LOFTSMAN'S TRADE

[Prepared by the Federal Board for Vocational Education at the request of the United States Shipping Board and Emergency Fleet Corporation. Large copies of this chart may be obtained from the Federal Board.]

Classes of work done	*Men required for each class*	*Individual duties*	*Jobs done*	*Analysis of operations*
Lines	One linesman works alone or with 1 to 2 helpers or apprentices	Makes measurements and lays off lines on floor. Hold chalk line, hand linesman tools, and assist linesman as directed. NOTE. — Linesman is the highest grade of loftsman and may be called on to perform any class of mold loft work.	Draws sheer plan. Draws half-breadth plan. Draws body plan. Does most difficult laying out, especially jobs requiring knowledge of development and lifting of bevels.	1. Gets sheer, half-breadth, and body plans together with tables of offsets furnished by drafting room. 2. Draws half-breadth and sheer plans to large scale on large table or mold loft floor. 3. Corrects offset tables from this large-scale drawing. 4. Returns corrected tables to drafting room. 5. Pencils full-size body plan on freshly painted space on mold loft floor. This plan includes water lines, frame lines, etc. All necessary information for laying out any part of the vessel, such as shape of frames, floor heights, position of decks, stringers, longitudinals, shell plate edges, etc., may be obtained from it. 6. Furnishes pattern shop with necessary information regarding stern post, stem, hawse pipe, etc.
Frames	2 loftsmen 2 helpers or apprentices	Make measurements and lay off frames on floor. Hold chalk line, bore holes, paint symbols, tack templates, assist loftsman in general, and may lay off simple straight molds.	Lay out templates for— Frames, cant and square. Stringers. Longitudinals. Stanchions. Side frames. Bottom frames. Deck beams. Brackets. Clips. Angles. Build small templates. Furnish lay-out to template-maker for large frames.	1. Get template from stock or fair lines on floor for template to be built. 2. Fair template with lines on body plan. 3. Lay out and mark rivet holes according to standard tables. 4. Bore rivet hole in template. 5. Mark upon template number of pieces, position, frame number, boat number, and other necessary information for fabrication.

ANALYSIS OF THE MOLD LOFTSMAN'S TRADE (*continued*)

Classes of work done	*Men required for each class*	*Individual duties*	*Jobs done*	*Analysis of operations*
Decks and inner bottoms.	1 loftsman.........	Makes measurements and lays off decks and inner bottom on floor.	Lays out paper and wood templates for deck and bottom.	1. Lays out deck plan on mold loft floor showing position of butts and seams and all openings such as hatches, engine casings, etc. 2. Gets template from stock or makes new template to fit lay-out. 3. Indicates rivet holes by — (*a*) Boring holes in wood template. (*b*) Prick punching paper template.
	1 helper or apprentice.	As above.		
Shells............	2 loftsmen.........	Make measurements and lay off shell plates.	Lay out templates for all shell plating except special shaped plates and closing strakes which are lifted from ship by ship-fitters.	*See* Deck and inner bottom analysis.
	2 helpers or apprentices	As above.		
Bulkheads.........	4 loftsmen.........	Make templates for all bulkhead plates and shapes.	Lay out templates for all bulkheads and necessary angles, straps, plates, collars, staples, etc.	*See* Deck and inner bottom analysis.
	4 helpers or apprentices.	As above.		
Miscellaneous....	1 to 6 loftsmen.....	Lay out and make small templates for miscellaneous parts.	Lay out templates for foundation, freshwatertanks, masts, vents, etc.	*See* Deck and inner bottom analysis.
	1 to 6 helpers or apprentices.	As above.		

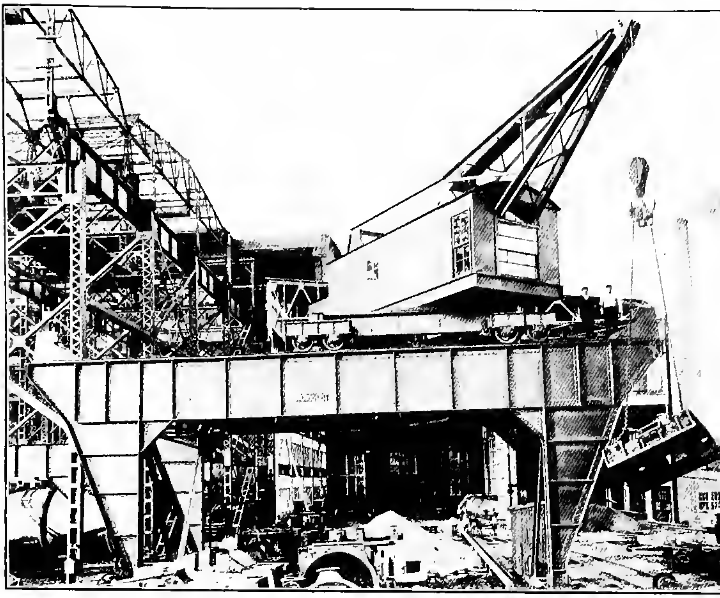
4. Crane men, either engineers of locomotive trains or unskilled men on electric cranes.

The man in charge of the yard must be intelligent and capable. He must see that all the material comes as ordered from the manufacturing mills, that the checkers do their work properly, and that materials are sent to the steel mill when asked for. He is responsible for the general good condition of the yard.

The steel mill is the place in which the steel frames and plates which constitute the hull of a ship are cut to size, bent to the desired shape, and otherwise prepared for erection. It is sometimes called the "plate and angle shop" or "fabricating department." It properly includes the milling, shaping, and assembling of parts in sections for erecting upon the ship.

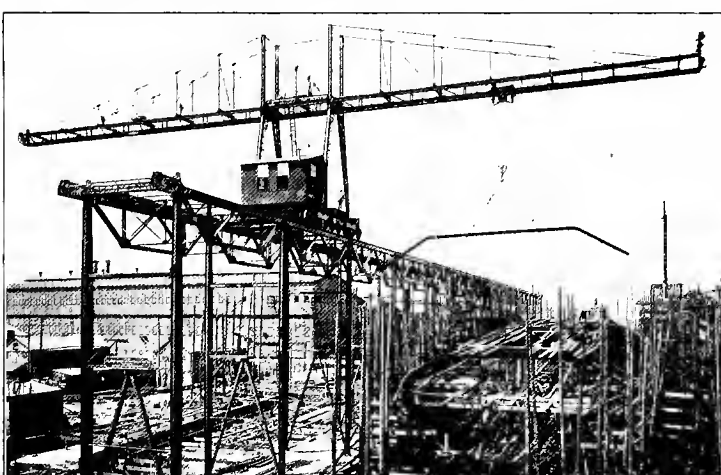
The mill is a large, long building open at both ends. It is high enough for the use of cranes and consists of two sections or sides with car tracks running lengthwise. All frame parts, or "shapes," are handled upon one side, and all plate parts upon the other, the work going on simultaneously.

First there is a ship-fitting or laying-out department or division of workers. This department secures the molds from the mold loft and "lays out" or marks off their specifications upon the shapes and plates brought in from the yard. After this the parts go through the various operations of punching, drilling, shearing, planing, scarfing, countersinking, rolling, and flanging. The parts for some portions of the ship are then assembled in shops inside the mill, or in the open air outside the mill. Where parts are to be bent but slightly the work may be done without heating, but where much bending is required both plates and shapes are heated in forges and furnaces.



A BROWNHOIST YARD CRANE

Used to handle castings and other heavy loads up to 30 tons. The crane spans three railroad tracks and travels back and forth above the cars to be unloaded



A TRAVELING CRANE USED TO LIFT TIMBERS, STRUCTURAL STEEL, AND MACHINERY

The yards employ engineers to operate the cranes and riggers who attach ropes or chains to the material to be put in place on the hull

The work of the mill includes also anglesmithing, acetylene cutting, electric welding, and weighing.

The list of workers of the mill is as follows:

1. Foreman.
2. Assistant foreman.
3. Leading men for shifts and gangs.
4. Layout men.
5. Drillers and countersinkers.
6. Punchers.
7. Shearers.
8. Planers.
9. Rollers and flangers.
10. Furnacemen.
11. Weighers.
12. Angle furnacemen and anglesmiths.
13. Acetylene cutters.
14. Electric welders.

The work of the steel mill is difficult and exacting. It calls for strength and skill. It is carried on by various gangs who are engaged in laying off, in different operations on the plates and frames, and in angle work and assembling.

The angle furnaceman or frame-bender shapes bars of angular cross-sections, using a large furnace for heating. He works from molds and bends the bars into the exact form desired. The anglesmith shapes small lengths of bars, heating them in a forge, and bends and welds flanges. He usually works from patterns. A blacksmith can be trained to do this work.

Anglesmiths and furnacemen must know how to read blue-prints, and must have a general knowledge of shipwork, and the terms used. The men employed as machine operators in the various processes of the mill must have a fair knowledge of the symbols and marks used in laying out shipwork. Furnace-work demands the heaviest and strongest men that can possibly be secured for work in the shipyard. In hand work use is made of sledgehammers up to forty pounds in weight.

The best men secured for work in the steel mill have been structural iron workers. Boilermakers, black-

ANALYSIS OF TRADES IN A STEEL MILL

[Prepared by the Federal Board for Vocational Education at the request of the United States Shipping Board and Emergency Fleet Corporation. Large copies of this chart may be obtained from the Federal Board.]

Classes of work done	*Men required for each class*	*Individual duties*	*Jobs done*	*Analysis of operations*
Anglesmith	1 anglesmith	Bends and welds small lengths and light angular shapes.	Bends and welds tank frames, door frames, frame staples, bulkhead staples, etc., using molds furnished by mold loft or lifted from strip by ship-fitters.	1. Takes molds furnished by mold loft or lifted by ship-fitters and selects stock. 2. Marks stock where it is to be cut or bent with cold chisel. 3. Puts bar in forge and heats it. 4. Bends bar to shape of mold or cuts when necessary with hot chisel.
	2 helpers: (a) Hammer man	Strikes as directed by anglesmith.		
	(b) Back handler	Handles material		
			Welds	1. Cuts stock to proper length. 2 Reheats. 3. Shapes to point where piece is to be welded. 4. Heats to welding heat. 5. Welds. 6. Smooths up job with flatter. 7. Tests with mold. 8. Hammers and shapes slightly if necessary.
Furnaceman or frame-bender.	1 frame-bender	Bends heavy structural shape working from molds.	Bends frames	1. Gets mold from loft or from fitter. 2. Lays mold down on bending floor. 3. Draws line around it on bending floor. 4. Measures back width of bar and draws second line. 5. Sets iron set or pins to this line. 6. Heats bar in furnace. 7. Draws bar out of furnace and makes one end fast with a dog. (In some cases center may be fastened instead of the end.) 8. Takes winder and bars and pushes free end around to the line or set. Bevels when necessary. 9. Releases bar and allows it to cool. 10. Hammers bar to final shape, fitting it to mold.
	4 or more helpers	Put in pins and dogs; put frames in furnace and draw them out; strike; use winder, bars, and other tools as directed by frame bender.		

ANALYSIS OF TRADES IN A STEEL MILL (*continued*)

Classes of work done	*Men required for each class*	*Individual duties*	*Jobs done*	*Analysis of operations*
Plate furnaceman	1 plate furnaceman 4 or more helpers	Shapes plates As above	Shapes keel plates, hoss plates, oxter plates and other plates requiring special work and heating to shape them.	1. Gets mold from mold loft or in special cases goes to ship and lifts it. 2. Makes cradle or frame of angles and plates to fit form of plate wanted. 3. Puts cradle on blocks on bending floor. 4. Heats plate. 5. Draws out over cradle. 6. Hammers with dolly bar and sledges. 7. Gives final shape after it has cooled somewhat as it curls away from the cradle when cooling.
Machine operators on	1 operator 2 to 4 helpers	Operates machine and shapes work to fitter's lay-out. Handle material and assist operator as directed.		
(*a*) Mangle			Straightens plates	
(*b*) Drill presses			Drill and countersink plates	
(*c*) Shears —				
Rotary			Cut curved plates	
Straight			Cut straight cuts	
Angle			Cut angles	
(*d*) Manhole punch			Punch large holes	
(*e*) Rolls			Bend or roll plates	
(*f*) Hydraulic joggling machine.			Flange plates	
(*g*) Planers —				
Angle			Plane Angles	
Plate			Plane plate edges	
(*h*) Friction saw			Cut-off shapes	
(*i*) Punches, horizontal, vertical.			Punch holes	
(*j*) Acetylene torch.	1 burner, works alone		Cuts out large holes which cannot be punched.	

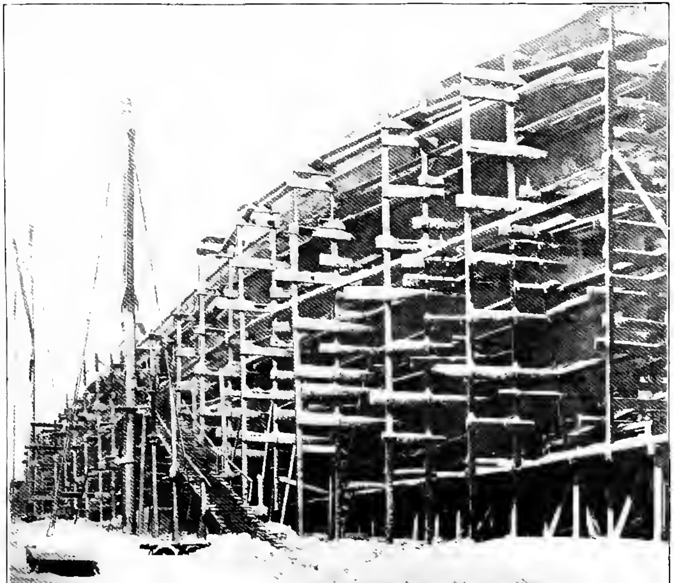
smiths, ship carpenters and joiners, and men who have been used to doing heavy and laborious work are employed in the mill. Frequently it is necessary to search out such men in the shipyard and transfer them to mill work.

The trades of the steel mill are not usually open to boys. They are generally filled from the ranks of helpers who learn by actual experience in gangs. Unskilled men are put on as helpers, doing rough work at first, assisting anglesmiths, furnacemen, and other expert workers, and as they progress they are put on small jobs of frame-bending and shaping, and machine operating. A man who does not prove effective at one kind of work is usually tried upon another kind.

In a shipyard employing ten to twelve thousand men, seven or eight hundred are found in the steel mill.

Ship-fitting consists in the marking of steel plates, channels, and other parts preparatory to their fabrication in the steel mill and installation on a ship. The ship-fitter has charge of assembling and erecting all metal parts upon the hull of the steel ship. He measures up pieces of work, makes templates, and fabricates certain parts when necessary and bolts them into place. The work is somewhat of the nature of that done by the loftsman. It embraces the following divisions:

1. *Lifted work.* When the mold loft has not supplied a template, it is sometimes necessary to make one from a part of a ship already in position. The fitter then lays the pattern material upon the part to be reproduced and marks it off for hole punching and shearing, thus producing a template. He may also place shapes and plates where they are to go and mark them off in the same way.



SCAFFOLDING ABOUT A SHIP UNDER CONSTRUCTION

Part of the work done by ship carpenters. Workmen in the outdoor trades must expect certain hardships. On the Atlantic Coast, even as far south as Virginia, the winters are cold and disagreeable

SHIPWRIGHTS AT WORK ON MASTS AND BOOMS

Even in the steel yards, the joiner shop and pattern shop and the work of yard maintenance call for many skilled men from the woodworking trades

2. *Mold work.* This calls for getting molds and instructions from the mold loft, and from them marking and working upon the material to be fitted for installation upon the ship.
3. *Laying out.* In this division a fitter takes a drawing and lays out or marks off the holes by using only the rule, square, and compass. He also indicates the lines for any necessary trimming or shearing.

Fitters work in gangs under leading men who thoroughly understand the requirements of ship-fitting. The gangs are grouped as follows:

1. The shell gang, working on the outside hull of the ship, and doing laying-out on the plates.
2. Framing gang, fitting frame plates and beams.
3. Bulkhead gang.
4. Deck gang.
5. Stringer and deck girder gang.
6. Miscellaneous gangs, doing fitting work on smaller parts of the ship.

The fitter is usually expert either upon framing work or upon plate work. A person learns ship-fitting either by apprenticeship or by working as a helper. Sheet-metal workers, structural steel men, and joiners generally make good fitters. It is necessary to be able to read drawings, and many persons in this occupation are usually familiar with the fundamental principles of plain geometry, and the practical applications of it. It is necessary also to become familiar with the names of the various parts of a ship.

Boys start as helpers to first-class fitters, and if they are apt, they can lay out small jobs in from three to six months. If they have had experience in the mold loft, this

will help them. There are very few regular apprentices in the trade, as the boy or man is likely to leave the yard as soon as he gets a general knowledge and hire elsewhere as a fitter.

The large yards provide courses of training in ship-fitting. A typical course is the following, which is given at Fore River:

COURSE FOR SHIP-FITTERS

1. Practical geometry and mensuration required for ship-fitters' work.
2. Instruction to become conversant with all drawings.
3. Names and various parts of ships.
4. Method of fairing of lines. Lay out decks. Camber and sheer.
5. Framing, bow and stern, laying out and marking bevels on templates.
6. Laying down and making molds for bulkheads.
7. Laying down and making molds for various foundations.
8. Method of lining up on ship for foundations and erecting same.
9. Lifting molds from ship and marking up same correctly, to be worked by other men in ships.
10. The development of cylinders or pipes and cone shape at various angles.
11. Conventional riveting symbols.

The term "shipwright" properly means shipworkman, or one working on wood and on iron parts associated with wood. The term "ship carpenter" is also in general use, but his duties should not be confused with those of the joiner or wood finisher.

The shipwright does all the woodwork about a ship except cabinet-work and finishing. He builds foundations, erects and trues the way in which the ship is constructed, lays keel blocks, sets up shores, erects stages,

ANALYSIS OF SHIP-FITTER'S TRADE

[Prepared by the Federal Board for Vocational Education at the request of the United States Shipping Board and Emergency Fleet Corporation. Large copies of this chart may be obtained from the Federal Board.]

Group divisions	*Gang divisions*	*Individual duties*	*Jobs performed*	*Job analysis*
Frame gang......	2 first-class fitters... 2 to 3 fitters' helpers	One fitter works on plates. Other fitter works on shapes. Helpers assist fitters as directed; hold chalk line; center punch plates through molds; assist in placing molds on plates for marking; mark rivet holes to be punched with marker; paint rivet holes as indicated by center punch marks; rough bolt the work as directed.	Lays out and assembles. Frames: Bottom frames, side frames. Reverse frames: Bottom frames, side frames. Brackets: At bilge, at decks. Floors: Water-tight, nonwater-tight. Clips: Vertical keel, longitudinals, stringer, bracket.	1. Gets molds from loft. 2. Orders stock into plate and angle shop. 3. After it is furnaced, marks stock, as indicated on molds, for punching, shearing, flanging, and location on ship. 4. After fabrication, assembles frames in sections, rough bolting up. 5. Assembles tower section, rough bolting frame and reverse frame angles to vertical keel and longitudinals to floor plate. 6. Assembles upper section, rough bolting brackets, angles, and clips to side frame. Midship frames are generally assembled in four sections, the forward and after frames in two sections, extreme ends in one section. Frames are installed by riggers and faired up by shipwrights.
Deck and inner bottom gang.	2 first-class fitters.. 2 to 3 fitters' helpers	1 fitter works on plates... Other fitter works on shapes Helpers' duties, as above..	Lays out............. Deck plates, tie plates, clips, angles, beams. Inner bottom: Plates, angles	1. Special shaped plates at end of closing strake are lifted from ship. (a) Fitter takes tools and battens to section to be fitted, adjoining work being already in place. He makes sure adjoining work is fair. (b) Clamps batten on the space where he is to make template. (c) Makes template to fit, using jackknife, hammer and tacks. (d) Nails other battens across for stiffeners. (e) Indicates on template all the necessary symbols, locates rivet holes, plate, frame, and hull numbers, also port or starboard. (f) Takes template to plate and angle shop and, if necessary, orders in his stock.

ANALYSIS OF SHIP-FITTER'S TRADE (*continued*)

Group divisions	*Gang divisions*	*Individual duties*	*Jobs performed*	*Job analysis*
				(*g*) Clamps template on plate and transfers all the template marking to the plate by chalk line and center punch. (*h*) Removes template and with enamel or paint indicates all rivet holes, shearing, scarfing, and indication marks. 2. All other plates are developed in mold loft and fitter only performs operations (*g*) and (*h*). Deck plates and inner bottom plates are installed by riggers and faired up by shipwrights. Some decks are all plated, others partly plated and covered with wood.
Shell and vertical keel gang.	2 first-class fitters . .	On lifted plates, one fitter makes the templates, other fitter marks the plate. On plates developed in loft they both mark the plates.	Lays out shell plates by strakes, including special plates, garboard, sheer, oxter, tuck, boss, doubling, counter.	1. Special shaped plates and closing strakes are lifted from ship. 2. All other shell and vertical keel plates are developed in loft. See deck gang analysis. Shell plates are installed and rough bolted up by riggers.
	2 to 15 fitters' helpers.	Helpers' duties, as above, except rough bolting, which is done by riggers; second-class fitters mark the regular plates.	Vertical keel, plates, butt-straps, and angles.	
Bulkhead and casings gang.	2 first-class fitters . .	One fitter works on plates, other fitter works on shapes; part of the time they work together.	Lays out and assembles bulkhead and casing plates, brackets, butt-straps, plate collars, seam straps, angles, channels, bulb angles, staples, clips, bosom pieces or angle butt-straps.	1. Plate collars, bosom pieces, and some staples are lifted from ship. 2. All other bulkhead and casing plates and shapes are developed in loft. Divisional bulkheads between decks are fitted by this gang. All heavy work is installed and rough bolted by riggers. All light work and fairing up is done by fitters.
	2 to 3 fitters' helpers	Helpers' duties, as above.		

ANALYSIS OF SHIP-FITTER'S TRADE (*continued*)

Group divisions	*Gang divisions*	*Individual duties*	*Jobs performed*	*Job analysis*
Stringer, deck girder, and longitudinal gang.	1 first-class fitter, 1 fitters' helper.	Work together..........	Lays out and assembles side stringers, upper, lower, panting; deck girders, inboard and outboard; longitudinals, first, second, third, etc.; breast hooks.	1. Bosom pieces for stringers, girders, and longitudinals are lifted from ship. 2. All other plates and shapes are developed in loft. Stringers, breast hooks, and deck girders are assembled as complete as possible on ground. Longitudinals are assembled on ship. All heavy work is installed and rough bolted by riggers. All light work and fairing up is done by fitters.
Miscellaneous gangs.	Several gangs, each composed of one first- or second-class fitter; one helper for each fitter.	Each gang works separately.	Lays out and assembles: Foundations, deck, auxiliary, engine and boiler, trunks, ventilation, coal, deckhouses, stanchions, manholes, fresh-water tanks, masts, king posts, hatches, oiltight, water-tight, nonwater-tight, coal, cargo; butt-straps, seamstraps, staples, bulwarks, shaft tunnels; doors, water-tight and nonwater-tight liners.	All templates furnished by loft, except bosom pieces and frames fastened to casing and bulkheads. All templates are generally lifted from ship. All heavy work is installed and rough bolted by riggers. All light work and fairing up is done by fitters.

sets backings for riveters, and prepares the slip for launching.

The first step in the construction of a ship is the preparation or repair of the berth, which, if kept in good condition, will serve for the building of many ships. As the work must be done at the water's edge piles are driven in the ground and heavy timbers placed upon them to sustain the great load of the ship when erected. In some cases heavy concrete foundations are laid.

After the slip is prepared, the keel line of the ship to be built is determined, and a tight line or ribbon is stretched down the middle of the space to fix the place on the keel blocks. These are laid crosswise upon the foundations of the berth. The top of the keel blocks is built up to the straight line except at the ends where the curve is determined by a template.

The shipwright or carpenter assists in placing the keel upon the blocks, and in stretching other lines to determine the shape of the bottom of the ship. He helps also in putting the bulkheads in place.

Shoring consists of placing and wedging the supports of the ship as it is being built. These supports are put under parts of the hull where extra weight comes to bear.

The staging or scaffolding necessary for the construction of a ship is built up in movable sections, with parts usually bolted together, so they may be easily taken down and used again. Staging consists of strong upright timbers and heavy planks, capable of bearing considerable weight. Platforms of planks are built one over another, six feet apart, running up to the extreme height of the ship, and three feet clear of the hull. When the ship is completed the temporary staging at the stern is removed for launching, but the other remains in place and

is taken down afterwards. This work is repeated with the building of every ship.

Stagings and supports are built inside the hull and bolted solidly to the frame of the ship as inner construction proceeds.

As the vessel nears completion the preparation of launching ways is begun. These consist of two separate parts, ground or fixed ways and sliding ways, which carry the ship down along the surface of the fixed ways. One side of the "cradle" or sliding part which supports the ship as it moves into the water is shown in the illustration on page 140. It is the part marked SAF1, SAF2, SAF3. Long steel cables fastened by bolts, the heads of which are seen projecting from the vertical timbers, connect it to a similar sliding way on the other side of the ship. The upper timber of the ground or fixed way upon which the "cradle" slides is marked ST11. The fixed ways are built upon the same slope as the keel and along each side of it. The sliding surfaces where the two parts come together are carefully planed and then greased so that the ship can move easily and smoothly when it is released.

When the time for launching comes, the row of wedges shown in the illustration just below the letters SAF1 are driven into the movable ways on both sides of the ship. This lifts the hull off the keel and shoring blocks and they can be removed. The weight of the ship then falls entirely upon the ways. It is held in place, however, by stout oak planks which must be sawed off before the ship can move. The pressure of its own weight is sufficient to start it down the incline.

All other work in the divisions just enumerated, many subdivisions of work connected with them, and other

similar work where heavy wooden parts and metal parts come together, in connection with ship-framing and machinery, are done by the shipwright. He installs heavy wood decks, wood foundations for machinery, cuts and fastens cargo battens, and makes and installs wooden masts, spars, and booms.

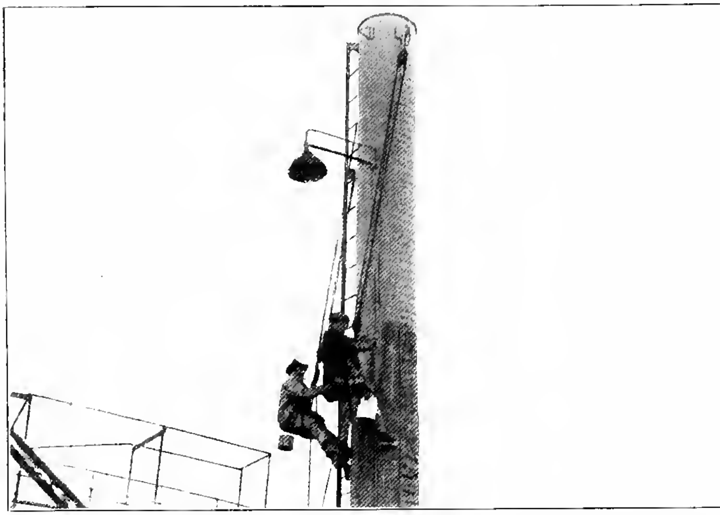
The list of workers in this division is as follows:

1. Foreman, or shipwright.
2. Assistant foreman.
3. Leading men.
4. Shipwrights.
5. Ordinary carpenters.
6. Fasteners.
7. Stage-builders.
8. Helpers.
9. Apprentices.
10. Spar-makers.

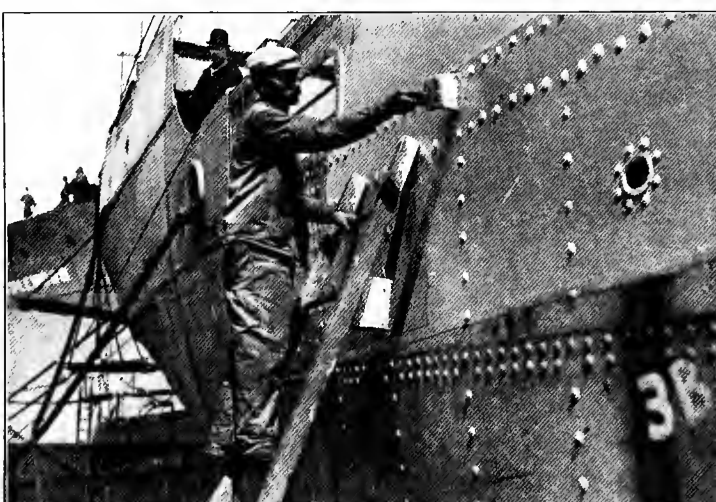
This division of shipworkers includes about four per cent of the employees of a shipyard, and two thirds of the number are usually ordinary carpenters. Where a distinction is made between shipwright and ship carpenter, the former term means the more expert and experienced workman.

A few apprentices are found in this department, but in most cases the workers are recruited by helpers who are trained in service, and by woodworkers and other mechanics who are secured through the employment department of the yard. Boys who wish to learn the trade may start in as errand boys. A great many begin in the mold loft. After tiring of inside work, they usually go with a ship carpenter, as it is part of the ship carpenter's apprenticeship to put in at least six months' time in the mold loft. During their apprenticeship the first year is spent with a ship carpenter, on first-class work, and about six months is spent in the mold loft familiarizing themselves with the use of the various tools, spar-making, and finally at the deck-calking.

Helpers who have acquired the ability to read ordinary



PAINTING A SMOKESTACK AFTER ITS ERECTION ON THE HULL



COVERING THE HULL OF A STEEL SHIP WITH ITS COAT OF ANTI-CORROSIVE PAINT

First-class shipyard painters finish the products of the joiner shop. Their work resembles that done by first-class house-finishers, sign-painters, and piano-finishers

drawings and have a practical knowledge of the trade are used to a great extent as second-class men. There are more of these men employed in the yards than first-class ship carpenters.

The best shipwrights are men who have been employed in building canoes, fishing boats, and wooden ships. Any man accustomed to heavy carpenter work, or any country boy of good physique and average education, can break in after a short time by starting as a helper. Many shipwrights have come from the small towns along the rivers of the Atlantic Coast where small boats are being built. House carpenters, millwrights, dock-builders, lumber-jacks, and other men who are accustomed to the cutting and handling of heavy timbers take very readily to this trade.

The work of the shipwright requires some skill in checking up lines in order to be certain that they are accurate. Much of the work is done with the broadaxe and adze. Carpenters accustomed only to using a hammer and saw and other lighter tools will find themselves at a disadvantage.

The qualifications necessary for the trade of the shipwright may be summarized as follows: Good health and strength; ability and willingness to work out of doors; a good eye for sighting lines; grammar-school and preferably high-school education, particularly a knowledge of practical geometry for lining and squaring and the ability to make simple calculations; ability to read blue-prints, to make rough sketches, and to measure accurately; a knowledge of the size, strength, proper use, and management of timbers and shoring; for all special shipwork a knowledge of the name, form, location, and use of the different parts of a ship, including metal as well as wooden

parts; skill with carpenter's tools, including especially the broadaxe and adze. Carpenters used to using only a hammer and saw and other lighter tools are apt to find themselves at a disadvantage at first.

After the yard-riggers deliver the plates and frames to the berth where the ship is to be built, it is the work of the erecting gang to place them in their proper positions. Each leading man, or erector, has working with him several bolters, carpenters, and unskilled helpers.

After the carpenters have lined up the keel blocks, the erecting gang lays the keel and begins the work of putting in place the steel framework, floors, and steel plating for the outside of the hull. Every part is marked in such a way as to indicate its exact position. The erector must learn this system of marking, and must be thoroughly familiar with the various parts of the ship and with the reading of blue-prints.

Skilled men, having considerable experience in the yard, are required to direct this work, but unskilled men can readily be trained to act as helpers.

As a rule, the entire work of erecting the hull is done out of doors with no protection whatever from the weather. On account of the heavy rainfall at certain seasons, a few of the West Coast yards have built sheds to cover their ways. One of the unique features of the New York Shipbuilding Corporation's yard on the Delaware is the fact that its shipways are roofed over, making it possible for men to work continuously in severe winter weather.

When the plate is hung by the erecting gang, it may be held by a bolt or two through holes that are several spaces out of place. Adjusting the plate to its proper position usually requires a plate-setting gang consisting

of two men, a plate-setter and a helper. They first size up the job to see just where the plate is to go. The frames, plate, and surrounding plates are studied. Then the plate is forced to its proper place by the use of drift pins, tapering pieces of steel driven in with a maul. Enough bolts are put in to hold the plate securely in place. By studying the size of the openings and the position of the plate, a skillful setter will draw the plate to its place without binding the bolt and stripping the threads or breaking it. In doing this, a small bolt is inserted first, then larger ones until the necessary force can be exerted.

The work requires skilled men. They usually begin by bolting up. A hand riveter or a fitter may take up plate-setting, but this is an exception to the general practice because most yards pay less for plate-setting than for riveting or ship-fitting.

Liners are filling pieces made from liner steel or packing. Tapered liners are used in the shell plating at every overlapping end joint in order to make the work perfectly tight. They are usually made long enough to take three or four rivets. Bolters assist the erectors in lining various parts of the hull and fit special liners in places where the plates cannot be drawn tightly together.

Following the erectors and plate-setters, comes a large gang of bolters who further line up all holes by drifting and bolt everything solidly together. Their work consists in placing the bolts in the rivet holes and in tightening the nuts on them with a long-handled wrench. If the joints are not tight, or if the bolts are too far apart, the hot rivets tend to swell out between the inner surfaces of the two plates when they are being riveted together. Driving the rivet does not draw the plates together in the least; they must be bolted solidly to begin with.

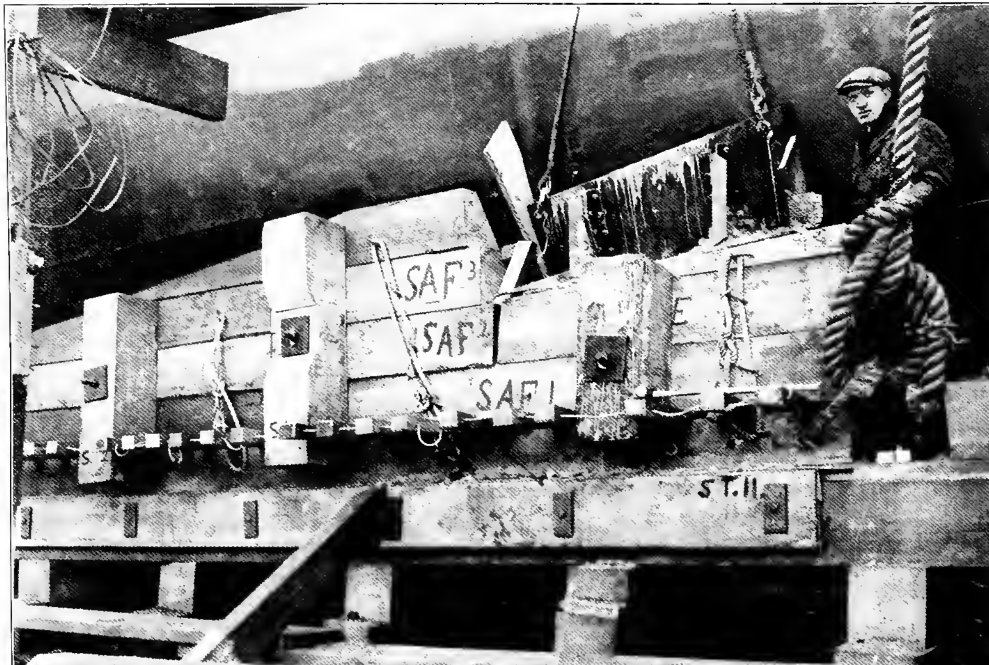
The claim has been made that the work of the bolter cannot be followed for more than two or three years without serious danger to the man's health due to the constant strain on the arm muscles in operating the wrenches. Several attempts have been made recently to modify this work in such a way as to relieve it of this unfortunate feature.

A hydraulic plate tightener recently invented by Archer B. Clark of Seattle is said to enable two men to do the work formerly done by twenty hand bolters. The machine weighs but fifty-eight pounds and is readily portable. In using it, the plates to be bolted up are placed between two compensating nuts on a piston which takes the place of the bolt used in the hand method of tightening. A lever worked by hand forces oil down on the head of the piston-rod in a closed chamber until a pressure of twenty tons is exerted in drawing the plates together.

Although bolting is an important operation, since many rivets can be spoiled and work is lost if it is not well done, it can be easily learned and there are no special requirements. Any man of average strength and intelligence who is willing to work outdoors can take up this trade. If he is capable, there is ample opportunity for promotion to more skilled occupations.

The drillers and reamers in shipbuilding drill, ream, and countersink holes in various parts of the ship which cannot very well be completely prepared before they are in place on the frame. Pneumatic and electrically driven machines are used for this work.

Drilling consists in boring holes in wood and steel, in preparation for the work of installation done by electricians, joiners, plumbers, and sheet-metal workers. A considerable amount of heavy drilling is required in the



LAUNCHING WAYS

For a complete description see page 135

erection of smokestacks, and on the decks and shells of destroyers and submarines. Bad rivets of the countersunk type are removed by drilling a hole part-way through the rivet and forcing it out with a punch. Another part of the work of the driller is cutting the threaded holes for tap rivets. These rivets are screwed into place instead of being driven and are used in places where it is impossible to get at both faces of the work to head up a driven rivet.

The illustration facing page 182 shows one of the special "rigs" used to steady the tool and to force the drill into the metal. On light work only one man is required, but on heavier jobs, two work together.

After erecting and bolting, many rivet holes fail to appear perfectly clear due to the fact that the plates have not been punched accurately, or because the two plates do not fit exactly together. Besides enlarging these holes, the reamer tapers, trues up, enlarges and countersinks holes wherever it is necessary. The countersink is a large tool sharpened to an angle at the point used in enlarging the face of a hole to take a countersunk rivet or head. The work closely resembles drilling except that no rig is used to hold the tool. The cutting material used on drills, reamers, and countersinks is soap and water, or a special cutting oil.

Men with good health and a willingness to work out of doors are the only ones who make good drillers and reamers. It is not necessary that a man be able to read blueprints, as all the work is laid out for him. In drilling, he must be able to use ingenuity and judgment in order to choose and place the proper rig for each job. He must acquire skill in handling the drill so as to drill straight and to the right depth and no more, and it takes some

time to learn the proper speeds to be used for the different sizes of drills and different metals so as to drill as fast as possible without overheating or injuring the drill. It is also necessary to hold and control the tool in all manner of places and positions, and this comes only by actual experience.

No apprentices are trained in this division. Men accustomed to using drills of any kind, such as quarrymen, stone-cutters, and drill-press hands, can very readily take up this kind of work. After two or three weeks working with an experienced man, they can be put on odd jobs and by actual experience accuracy is acquired. Men who have been accustomed to drilling or reaming with air tools on structural steel work of any kind are fully qualified to undertake this work.

In the steel ship, the principal outward features are the shell plating and the decks composed of numerous plates riveted together, but such a hull would lack many of the essential qualities of a seagoing vessel. A ship must have enough strength and rigidity to support the heavy machinery and other equipment, and when deeply loaded with heavy masses of cargo, it must withstand the tremendous water pressure tending to collapse the sides and bottom. It must likewise bear the violence of the sea in pitching and twisting and rolling from side to side. In order to provide against these straining forces, the designer employs a system of frames, bulkheads, floors, and other bracing devices depending upon the type and size of the ship.

The different plates and angle irons must be put together in such a manner as to prevent any perceptible bending of the hull or of the parts; otherwise the numerous riveted joints would soon become loose and admit

water or give way entirely. On the trustworthiness of the rivets life and property depend. Because of their importance in the development of the industry, it is not too much to say that the history of steel rivets is the history of the steel ship business. Much attention is given to the quality of material used in their manufacture and to the workmanship of fixing them in place.

Some estimate of the number of rivets required each year in a large yard may be drawn from the fact that over 650,000 rivets are needed for the construction of the average 10,000-ton ship. Many of the yards manufacture their own rivets, but nearly all the bolts are made by outside companies. Both bolts and rivets are made from round bars of steel of diameters corresponding to the sizes needed. The process is essentially the same in both cases.

The bars are first heated in a furnace and then fed into a machine which automatically forms the rivet heads and cuts the bar into the right lengths.

One machine can turn out 14,000 to 17,000 pounds of one-inch or 8000 to 10,000 pounds of three-fourths-inch rivets per day.

One or two skilled workmen are needed to tend the machines. All the other work is done by unskilled laborers.

Rivets are worked while red-hot. In this condition, they are pushed through holes in the plates to be joined, the head is set up against the plate on one side, while a new head (called the "point") is formed on the opposite side by blows from a special hammer. The various kinds are named according to the shape of the head. (See illustrations on page 178.)

For ship work on punched plates where water and oil

tightness is necessary, a special form called a "swell-neck rivet" is used having the portion of the shank near the head slightly tapered. It more completely fills the hole in the plate, since a punched hole is slightly larger on the side from which the metal is punched out than on the side from which the punch enters.

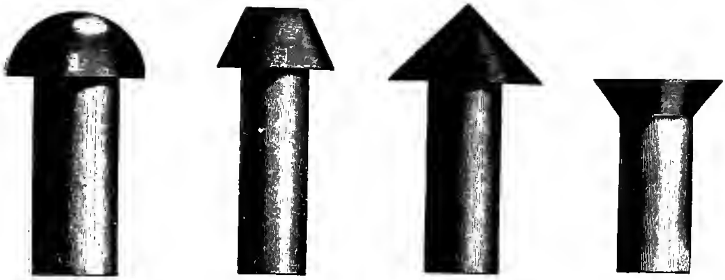
For drilled holes, the straight-neck rivet is used for water-tight or oil-tight work.

Riveting is done both by hand and with automatic hammers operated by compressed air. On machine riveting, a gang usually consists of a riveter, a holder-on, a passer, and a heater. Some yards dispense with the passer.

The rivets are heated, five or six at a time, in a small portable furnace. Coke, gas, or oil is used for fuel and a blast from the compressed-air hose produces a hot flame. Just before the rivet grows hot enough to throw off sparks, the heater removes it with a pair of long-handled iron tongs, and tosses it to the passer. The latter catches it in a keg or bucket if it must be thrown a considerable distance, as is often the case when riveting on parts of the hull where it is difficult to support the furnace near the work. Seizing it with his tongs, the passer inserts the red-hot rivet into the hole. The holder-on holds it solidly in place with a heavy hammer, called a "dolly," or a pneumatic tool placed against the head, while the riveter shapes the opposite end with his riveting hammer.

The illustration on page 178 shows the various ways in which rivets are headed up or staved.

At first the rivet is struck by the hammer fairly on the end, so that the shank may be thickened and fit the hole throughout its length. If it is a countersunk point and the rivet shank is rather long, it is then struck slightly to one side of the center. This bends it over in such a way



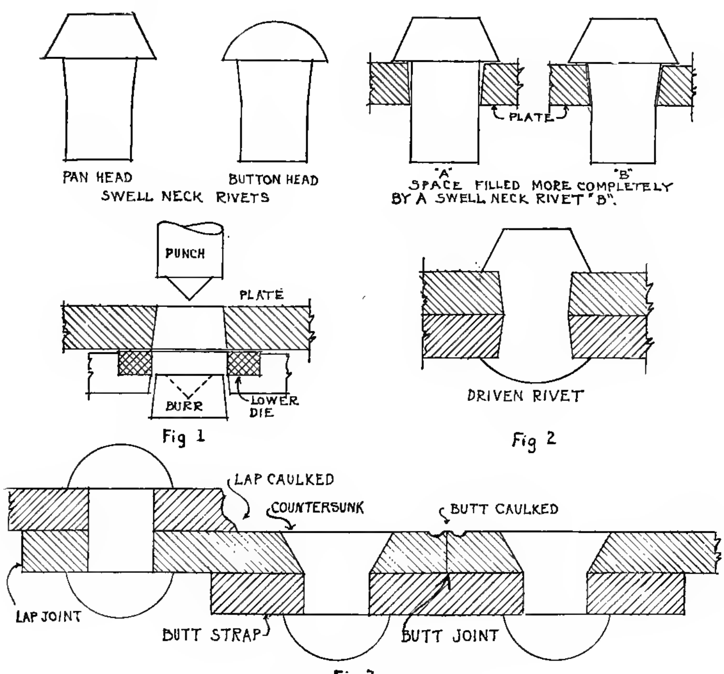
Button or Snap-
Head Rivet

Pan Head
Rivet

Cone Head
Rivet

Countersunk
Rivet

TYPES OF RIVETS USED IN STEEL SHIPS



RIVETING AND CALKING

Upper Row — Swell-neck rivets used for punched plates to make the joints watertight
Fig. 1. The punching machine makes a cone-shaped rivet hole in the plate
Fig. 2. A swell-neck rivet in place. Fig. 3. Calking, joints, and riveting

that the extra material not required to fill the countersink bulges to one side and can be readily chipped off while it is hot. The riveter then lays aside his riveting hammer and uses an air-driven chipping tool to cut away the extra metal.

While the first rivet cools, a second is placed and staved up. The riveter then returns to the first rivet and gives it a second series of well-directed blows around the edge, so placing his hammer that the metal rises slightly at the center. This process calks the rivet and finishes it off smoothly.

Hand riveting does not differ essentially from machine riveting. It is especially adapted to cleaning up odd pieces of work because no hose line for air needs to be laid. It is also used for light work, on places like the bilge of the boat where two edges meet that need to be drawn together, or on finished surfaces where the air machine is likely to scar the surface to a greater extent. A right-hand and a left-hand riveter strike together, standing on either side of the rivet.

All rivet work is tested in order to be sure that the rivets are tight and sound. The closeness of a joint may be tested by means of a thin-bladed knife, the insertion of which between the surfaces should not be possible. Testing may also be done by striking with a light hammer, the sound and vibration being used as a gauge of whether or not the rivet is tight.

Rivets are cut out only when very loose. "Hardening" is usually resorted to. This operation is the same as ordinary riveting save that the rivet is cold. In this work the holder-on usually runs his hammer simultaneously with the riveter. In case it is necessary to remove the rivet, the head is cut off or a hole is drilled through it, and

the rivet is driven out with a maul and "backing-out" punch.

Practically all of this work is done outdoors. Part of it, such as putting together bulkheads, frames, and braces, goes on in the yard, but the bulk of it is done on the ships under construction. The tools are heavy and in order to handle them effectively the workman must be strong and well built.

One of the difficult things to learn is to rivet either right- or left-handed and in any position. Experience in any kind of riveting is a help, but men not accustomed to making water-tight joints must learn to exercise more care and skill. Workmen who have done light riveting in any form of structural steel or who have riveted on boiler work can quickly learn to do the same type of work in shipbuilding.

It requires from three weeks to three months to develop a machine riveter. As a usual thing a man must work at least three months before he can be considered efficient. In learning the trade, many begin at holding on. In training a workman, he is put first on snap riveting. After he gains in skill, he is put on flush riveting or water-tight work. Persons accustomed to the use of air machines, such as chippers, calkers, and reamers, readily take up this work.

The holder-on requires less skill and training than the riveter. His work requires strength and quickness; young men or active middle-aged men are desired.

Heaters and passers can be trained in a few days.

The riveting gang is paid on a piece-work basis, the rate depending upon the size and style of the rivets driven and upon the ease with which the parts to be riveted can be reached.

All waste bolts and rivets are gathered and sorted. Old men, or persons injured in the yard, are frequently employed for this work. All bolts that can be used again are rethreaded and retapped. Some bolts are cut down from one sixteenth inch to one fourth inch to save them. Many damaged rivets are shortened up to make a smaller size.

Coke or fuel handlers supply coke or other fuel to the rivet heaters in the different riveting gangs. The work is not particularly heavy, and is often done by boys or old men.

The chipper trues up all irregular plates, cuts off plate edges that are too long, smooths rough castings, and cuts out loose rivets. An air tool, similar to that used by the riveter, driving various kinds of chisels, is used for this work as well as for calking.

By calking is meant the forcing of one surface of metal hard against another, thus producing a water-tight joint. A "splitting" tool is first used to make a narrow furrow along the edge of the plate about one sixteenth inch deep. A "setting" tool is then used to square out the groove and force the lower edge of the split against the other plate. It leaves a furrow in the metal from one eighth inch to three sixteenths inch wide and about one sixteenth inch deep. If very nice work is wanted, a third tool, known as a "finisher," is applied lightly.

On light work that must be water-tight, it is often better to weld than to attempt to calk the seam, since the operation in that case is very difficult.

Calking is also used to pack the joints of frames and beams where the bolter-up fails to bring the surfaces together. Where the rivet can be seen by looking between the two plates, a wedge-shaped piece of metal (a "shim-

liner"), slotted to fit around the rivet, is driven into the opening. The extra metal is then chipped off and the seam is calked. A skillful calker is highly valuable, since he can save cutting out many bad pieces of work by putting in packing and calking up.

The calker tightens up all shell-plate edges and seams, water-tight floors and bulkheads, trimming tanks, storage tanks, the tunnel for the propeller shaft, and many places on the decks. Some difficult work is done by hand, but probably ninety per cent of all chipping and calking is done with air machines. The operations on hand work are not essentially different from those described above.

The qualifications for chippers and calkers are similar to those for riveters. A good healthy body, ability and willingness to work out of doors, ability to work either right- or left-handed, and to hold the tool steady are necessary. Considerable skill is necessary in order to hold and control the tool in all places and positions. This skill can be acquired only by actual experience. Chippers and calkers often become riveters. Quarrymen, foundry chippers, and others accustomed to handling pneumatic hammers can very quickly learn to do this work.

Piece-work is the usual method of payment for all work of this character.

While the principal structural work on the hull is being carried forward, other groups of workmen begin painting both the inside and outside of the ship and a little later the installation of the woodwork, piping, electric conduit, and machinery begins. The sections which follow describe the details of the more important portions of this work.

The term "rigger" is applied in a variety of ways in the different yards. It may mean the man who follows a

SAWING THE "TRIPPER" PREPARATORY TO LAUNCHING

After the shoring and keel blocks have been removed, the sliding ways in place are sawed through, thus allowing the hull to slide down the incline into the water

crane on the ground in order to attach ropes or chains to articles to be lifted and to direct the crane operator. Men are needed for this work both in the yard and in the shops. A yard rigger may work alone or with from one to ten helpers, depending upon the size of the machinery or material to be transported.

Another common use of the word "rigger" is to denote the men who make in the rigging loft and install on the ship all the standing and running rigging and shrouds, sails, awnings, and cargo-handling equipment. An indoor rigger on this class of work splices and fits manilla and steel cables and sews canvas coverings. On the ships, riggers install the equipment of rigging, hawsers, guys, chain and rope tackles, and mooring lines.

In addition to their regular duties, the riggers' helpers are frequently called upon to assist other workmen on such jobs as launching, clearing away for the keel blocks, unloading cars, or clearing the ships of débris.

No apprentices are employed in these trades. Workmen are developed from helpers. Riggers in the loft need no special education and only the leading man needs to know how to read blue-prints. The men must know how to cut, fit, and splice wire and manilla cables and ropes. The best man for the rigging loft is a sailor. Cable splicers or tent and awning makers have had valuable experience.

To be a rigger or hitcher on outside work a man needs no special education, but should have good health and strength and be able and willing to work out of doors. He must have judgment in estimating weights and making hitches and ability to size up a piece and determine the best method of hoisting. Sureness and care are needed in hitching so as not to cause injury to himself or other workmen.

Structural iron men, bridge erectors, house movers, and outside riggers are the best material for a rigger on hoisting work. A rigger's helper on outside work, if he has good judgment, can learn to do ordinary hoisting in three to six weeks; large heavy jobs require more experience.

Under conditions as they existed some years ago, it was customary for the painter in the shipyards to be called upon to do every class of work, no matter how skilled a workman he might be. As the work is arranged at the present time, helpers, beginners, and third-class workmen are placed on those parts requiring little or no skill. As they learn the requirements of the trade and become acquainted with the practice in the yard, they are advanced to better positions.

The different kinds of work done by shipyard painters may be graded as follows:

First class. The work as it comes from the joiner's shop must be finished before it is sent to the ship. In many respects this work resembles that of the first-class house finisher, sign painter, or piano finisher. Much of it calls for skill of a high order. It consists in applying enamel, varnish, and better qualities of paint. Among the articles turned out are drawing boards, bulletin boards, various articles of furniture, the inside furnishings of pilot houses, and other articles enumerated under the head of the work in the joiner shop.

Interior decorating, especially on commercial ships, is a division of this work calling for special training and skillful workmanship. So few really fine passenger vessels, where correct artistic interiors are demanded, have been built in this country that firms of decorators specializing in shipwork have not been developed. In Europe,

firms of this kind not only design but build and furnish the interiors complete. House architects or decorators are occasionally called upon in this country for special shipwork. While they make a fair showing in view of the fact that conditions are entirely different from those usually met with in homes and public buildings, the results are far from being as satisfactory as those attained by specialists familiar with the peculiar problems of ship construction. With the growth of our merchant marine, this field will unquestionably receive considerable attention and should give rise to promising opportunities for young men who are interested in architectural design and interior decoration.

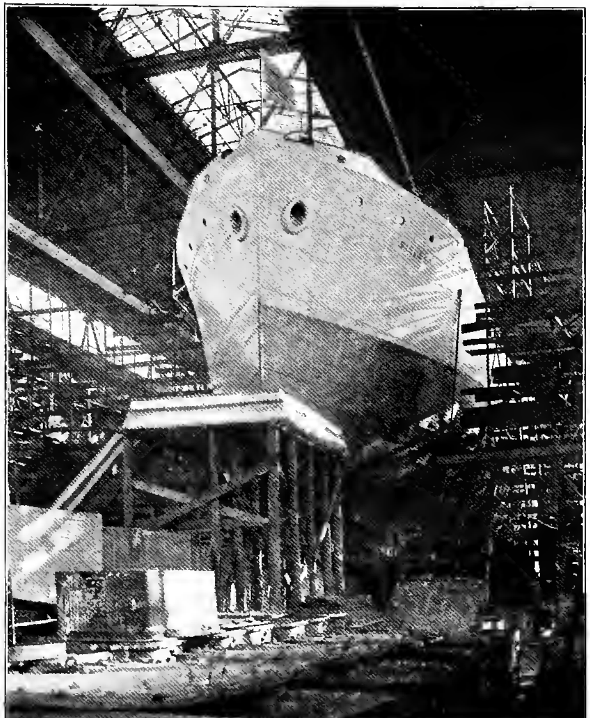
Second class. The entire structure of a steel ship, except the parts noted below which are covered with cement, receives a priming coat of red lead. The underwater portion of the hull is covered with anti-fouling and anticorrosive paint, and the other parts with special weather paints. Steel decks, bulkheads, and other parts to be ceiled or covered with wood receive at least two coats of red lead. Areas finished in white or spar color have at least two coats of color in addition to the red lead. A special division of this work is done by the steeple jacks, who must paint the masts and other parts of the superstructure. The transports and certain other ships are painted in camouflage, work which requires some artistic ability and special training.

Third class. The holds and the bottoms of the ships, except parts to be cemented, are painted over with a heavy red-lead mixture. Pitch mixture, tar, and asphalt are used to plug seams and openings. Much of this work is extremely dirty and unpleasant and because of the conditions under which it must be done is quite unattractive.

When a man enters the yard, if he has had little or no experience, he is put on third-class work, either painting or laying cement in the hold or applying the first coat to decks or stringers. He is then advanced to painting the outside of the ship; to engine-room work; then to joiner work; and finally to hardwood finishing.

The house painter is apt to find numerous disagreeable features connected with shipyard work. Nearly all of the work is hard; and it must frequently be done in a great hurry, since it is not possible for the painters to get at the ship until other mechanics are at least partly through. He very frequently finds that he is expected to work in the midst of a score or more of machinists, steam fitters, and electricians, instead of having the entire quarters to himself as is usually the case in house painting. The work is apt to be very much dirtier than that done outside. Several coats of quick-drying paint may be applied in the course of a day, and the painter is very likely to find his work badly disfigured by workmen from other departments who must follow immediately after him. It goes without saying that the work in the holds and in the ship bottoms is exceedingly disagreeable, not only on account of cramped quarters, but on account of the character of the materials to be applied, such as pitch, tar, and asphalt.

On the other hand, the painter in the shipyard finds that if he can accustom himself to the changed conditions he has many distinct advantages. In common with the other shipyard trades his pay is regular; there is no changing about from job to job; if he shows himself to be reliable and industrious his position and pay are permanent and are safely guaranteed. The house painter frequently waits for long periods for his pay, and may be



A MERCHANT SHIP READY FOR LAUNCHING

Ship carpenters keep the hull faired up during the construction and prepare the launching ways and the christening platform shown above

STARTING DOWN THE WAYS

Carpenters have knocked out the keel blocks in the center. The fixed ways with their surfaces greased are shown on either side

out of work for days at a time on account of inclement weather. On the ships bad weather does not influence his work to any appreciable extent. It is always possible to find inside work that can be done on unpleasant days.

Men who have done house finishing, sign painting, piano finishing, or any sort of painting connected with structural steel work can find ready employment in the shipyards. Men with absolutely no experience are able to learn the trade in one or two years. Men from twenty-one to twenty-eight years of age, without a trade, who are willing to suffer a little inconvenience in the first few months, will find this occupation easy to enter and one that offers many attractive inducements. At present the yards are very short of labor and painters are much in demand.

Cement layers and unskilled men who act as helpers are needed for concrete work in the holds and water tanks. In the water courses, or bottoms of the ships, it is necessary to fill in all pockets and crevices about brackets and frames and the joints between plates so that water can flow freely. The entire bottom of the ship, and of many of the tanks, is covered with a layer of Portland cement from an inch to an inch and one half deep. This is omitted only in the oil compartments of oil tankers. In some yards this work is done by the laboring or rigging gang under the direction of the Hull Engineering Department.

In a few large yards the paint shop mixes and grinds all its paint and white lead. Four or five men are employed at this kind of work. One leading man who is acquainted with the trade is necessary; the others are all green men who are trained in the shop.

In the yards working on Government contracts, con-

stant supervision is exercised over the work on each ship. Numerous tests are made, not only of the finished ship and of her machinery after it is in running order, but also of the various machine parts and ship-fittings while they are being built in the shops.

The tests made on the tanks of a new vessel before launching offer an excellent example of this kind of work. The test pressure is obtained by filling the tanks with water from a hose to the height of the vessel's load line. This puts the same pressure on the bottom and sides of the tank as will be sustained when the ship is afloat. The following directions for making such a test are taken from the "Shipbuilder's Pocket Guide" prepared by the American International Shipbuilding Corporation:

> Drill and tap a two-inch hole in the shell plating of the tank and attach a hose and cock; this will supply the water directly from the service mains to the tank. Run an escape pipe up from the tank top and overboard at the load line. A constant stream of water running from this escape pipe assures the tester that the tank is under the required pressure. After the test, an inside patch is placed over all holes and calked. A disk, of the same thickness as the plate, is riveted into the hole, if the appearance of the inside patch is objectionable. Tank tops must be kept dry when testing in order to locate leaks, and this is done by sprinkling sawdust over them wherever water shows.

Decks and bulkheads cannot be tested under pressure, and for such work a jet of water from a hose at about thirty pounds pressure is used. The jet is directed against the joints to be tested while a workman, stationed on the opposite side of the bulkhead, watches for evidences of leakage.

There are three principal divisions of inspectors and other Federal supervisors of shipbuilding:

1. The superintendent of construction has charge of all work as it is being developed in the shops, and must see that it meets the requirements of the Government contracts. His official title is *superintending constructor*. The company makes the tests as a rule, but a few experts are employed under the superintendent, who checks up their tests. About fifty per cent of his office force are clerks and stenographers. The remainder are practical workmen who make the tests, draftsmen, and engineers. A yard employing 10,000 workmen will require forty to fifty persons in this division.
2. The inspector of machinery has charge of the inspection of all machinery to be installed on the ship. A man employed in this work is required to have experience on ship electrical apparatus, and must have had a technical education and some practical experience in a variety of electrical work. Forty to fifty people are usually employed in this department. They are clerks and practical men who assist in the tests and supervision.
3. The cost inspector comes under the Paymaster of the Navy. On all Federal contracts calling for a cost-plus basis he must check up the costs as estimated by the contracting company. This work is divided between office work and that done by persons in the yard who check up the records of the company on production, materials, and wages. There are usually one head inspector and about seventy-five clerks, stenographers, and practical technical men for each yard.

All the above positions are civilian appointments secured through the Civil Service. The pay varies from $3 to $10 per day. Assistant draftsmen and copyists need no previous shipyard experience. The same is true of much of the clerical and stenographic work. Clerks and stenographers receive from $3 to $6 per day, depending upon the kind of work they are asked to do and the amount of responsibility they assume.

CHAPTER VII

THE METAL TRADES AND THE ELECTRICAL DEPARTMENT

IN addition to the steel mill, the principal metal-working trades in the shipyard are the following:

1. Foundry workers (copper, brass, and iron).
2. Blacksmiths.
3. Boiler-makers.
4. Machinists.
5. Galvanizers.
6. Sheet-metal workers.
7. Coppersmiths.
8. Plumbers and pipe-fitters.
9. Oxy-acetylene welders and cutters.
10. Electricians.

The following account of the work done by those who are employed in these shipbuilding trades represents the practice of the older and larger yards. In the smaller concerns and in the yards building so-called "fabricated" ships, some variations in practice are likely to be found, but the working conditions and the requirements for employees do not vary in any important respects from those described in this chapter.

After the patterns for machinery, ship-fittings, and other metal parts have been built in the pattern shop, they are sent to the foundry where the casting is made. Numerically, the two most important trades in the foundry are molding and core making.

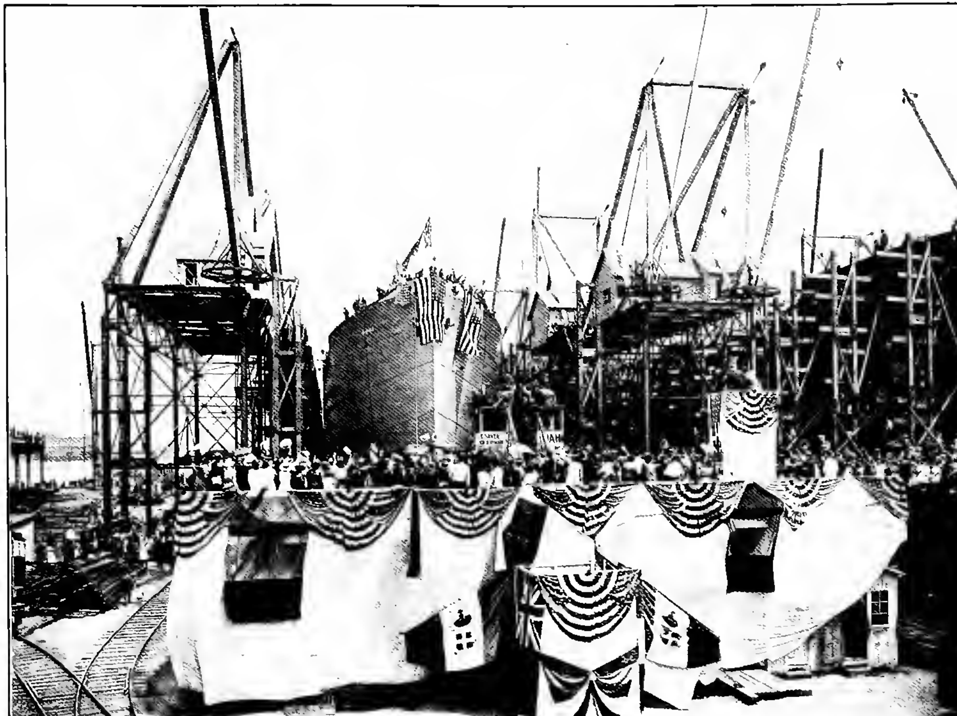
In the molding process, damp sand is packed about a

pattern in such a manner that when the pattern is removed a cavity exactly the shape of the pattern is left in the sand. Molten metal is then poured into the mold to form the casting. The work is usually dirty and heavy and much of it requires frequent stooping, bending, and lifting. Severe burns from the molten metal are not infrequent. The better grades of this work, however, are interesting and afford opportunity for the exercise of considerable skill and judgment. As a result of the introduction of machines and special methods of manufacture, second-class men who have worked for a short time as helpers now do much of the work formerly done by first-class molders.

Although the materials used are the same, core-making is exactly the opposite of the molding process. The core-maker prepares the sand cores which are placed in the molds where openings or cavities are wanted in the finished casting. In this case the sand is packed inside of the pattern instead of around it as in molding. The work calls for less physical strength and endurance than molding and a greater proportion of the workers belong in the semi-skilled class.

Only a few of the older and larger shipbuilding companies have iron foundries. There are numerous great iron foundries outside of the shipyards, which now supply to the yards parts already cast, such as propellers, iron castings, and ship frame work. Men experienced in these foundries and in smaller ones making articles cast in iron and steel can successfully and profitably enter the shipyards. At the present writing, the yards are finding it extremely difficult to get experienced foundry workers such as core-makers and molders.

The iron foundry in a large yard requires over one



THE LAUNCHING OF THE NAHMA, A TYPICAL STANDARDIZED VESSEL

A later stage of the launching is shown in the frontispiece

hundred men. About twenty-five tons of castings of various pieces, from bed plates and anchors to small fittings, are produced daily. Some of these castings weigh as much as fifteen tons. Such a foundry sometimes solicits outside work or does work for another yard.

The general work of the yard foundry differs but little from that of the ordinary iron foundry. The men employed are foundrymen, machine molders, core men, sand shovelers, and laborers. The expert workers are recruited mainly from the ranks of helpers. In most yards the majority of the men in these occupations are of foreign birth.

Nearly all shipyards have brass foundries in which are cast the parts of red copper and bronze now used in shipbuilding. The work differs from that done in the ordinary brass foundry in that a large part of it is upon high-pressure valves and pipe-fittings. It is therefore found necessary to use a harder and tougher metal which requires special methods in casting. It has been found that the ordinary brass molder does not readily adapt himself to this type of work. A good iron molder, however, easily adapts himself to this work and in a very short time becomes quite proficient. A first-class core-maker easily learns to do the work of the brass foundry of a shipyard, but the steel molder finds difficulty because he is not used to producing molds with as fine definition or as sharp corners as are required in this work.

The division of workers in the brass foundry is about the same as that of the iron foundry, including molders, core-makers, and helpers or laborers. In both cases helpers may become skilled in the trade. Others learn by serving an apprenticeship of three or four years.

Boiler shops are to be found in all of the older yards and in many of the newer plants working on the fabrication plan. This department builds the boilers complete, except for certain work to be done in the machine shop, and installs them in the ship. The brickwork is usually laid by masons who are also expected to do the repair work of the yard department. During a period of fourteen months, under the usual working conditions, one of the largest shops constructed thirty boilers for eleven different ships (two to four boilers per ship). Their total weight was 3,751,830 pounds. Twelve of these boilers were eighteen feet in diameter, weighing seventy-eight tons each. Besides this work, the shop turned out fifty-two tons of galvanizing tanks and all the forced draft boxes, uptakes, and smokestacks for the boilers.

Two important kinds of boilers are being constructed for use on steel and wooden ships. The fire-tube type is represented by the Scotch boiler shown in the illustration opposite page 162. This is known as a "fire-tube boiler" because of the fact that the heat of the fire passes through the tubes. The second type, known as "water-tube boilers," usually consists of one or more large drums or cylinders for water connected to a steam drum by means of small tubes through which steam and water pass. The Babcock boiler has straight tubes, while in the Normand or White-Forster the tubes are curved.

When the plans for a boiler are received from the drafting room, they are first turned over to a "layer-out." It is his duty to develop working plans from specifications and blue-prints, make templates of wood or metal, and mark the plates of steel and other material to indicate how they are to be sheared, rolled, machined,

and riveted. In some shops, all material is laid out from the blue-prints by measurements, no templates being required.

After the plates are marked, they are cut to size by a gang consisting of a first-class boiler-maker and two or three helpers. For this purpose very heavy shears are used, capable of cutting plates up to two inches in thickness. Some parts are cut with an acetylene torch.

Either before or after they are shaped, the metal sheets from which the larger drums are made must be machined at the edges and ends, both to reduce the thickness of the metal and to make the edges perfectly smooth. This work is done on very large planers or boring mills. In many plants these machines are a part of the equipment of the boiler factory, but in others these operations are carried out in the machine shops.

In order to bend the heavy steel sheets for the small size water drums into the right form, they are first heated in an oil furnace and then pressed into half-round size by a hydraulic press exerting a pressure of about fifteen hundred pounds per square inch. For shaping the front and back heads, furnace holes, and other small curved surfaces, flanging machines are used. This work usually requires one mechanic to direct the operation, one man to pull the levers, and from two to three helpers. Heavy mechanical rolls are used to bend heavy plates hot or cold. A skilled mechanic and two helpers are usually required for each set of rolls.

The smaller steam and water drums are made in two sections. The semi-cylindrical sheets of metal are either welded or riveted together. The larger drums are fastened together with long pieces of steel riveted over the seams called "butt-straps." These are planed and

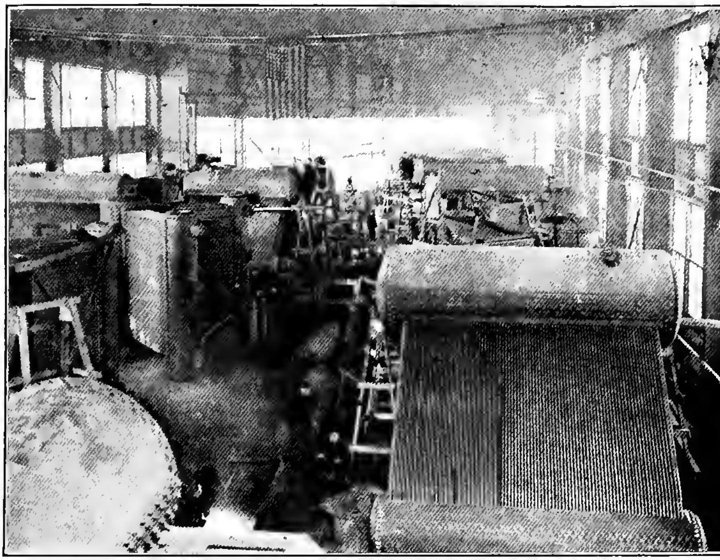
pressed to the right curvature to fit the outside of the drum.

On the smaller drums the holes to admit the tubes are drilled on a large drill press capable of boring several holes at once. In constructing the large Scotch boilers, the plates are machined, rolled into shape, the ends flanged, and a few holes bored through both the plates and the butt-straps to hold the sides and ends together. The boiler is then put on a shell drill for the remaining holes to be bored. This machine consists of a heavy platform on which the boiler stands, and two separate drills mounted on tracks so that they can revolve about the boiler. The operator's cage and the machinery operating the horizontal drill are mounted in such a way that an electric motor can shift them up or down. Another motor shifts the position of the drill on the track. The drill will drive through four inches of steel in about three minutes.

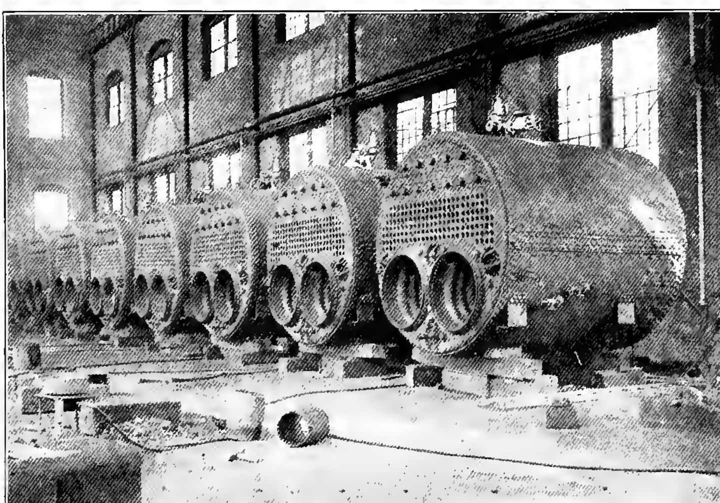
Operation of these drills requires no special training. Any alert mechanic can be trained in two weeks' time. He needs to know something of operating an electric motor, and must be quick and accurate so that no time will be lost in shifting and centering the drill.

Other drilling is done on large radial drills. Most shops have from two to four such drills, each requiring one operator. Holes for countersunk rivets must be countersunk to the thickness of the plate. This operation is exactly like drilling and can be quickly learned. After drilling the holes to receive the tubes on water and steam drums, the burr, or excess metal, must be removed from the inside of the holes with an air chisel or countersink. In some cases it is necessary to crawl inside the drums in order to do this work.

Rivets are set while hot with a one hundred-ton



WATER-TUBE BOILERS UNDER CONSTRUCTION



SCOTCH BOILERS WEIGHING 78 TONS FOR FREIGHT STEAMERS

Manufactured in the boiler-shop of Harlan & Hollingsworth, Wilmington, one of the oldest yards on the Atlantic Coast

hydraulic riveter. On the larger shells, the rivets are from seven eighths inch to one inch in diameter.

The preparation of the tubes for water-tube boilers requires several operations. About six inches of each end is polished by holding the tube against a rapidly revolving wheel made of compressed felt. The wheel has a V-shaped surface over which fine emery dust is sprinkled. Bending is done on a special machine operated by hand by four men. A fifth man inspects each tube after bending to see that it fits an iron template. The tubes are cut to the right length on a circular saw, and the ends are rounded both inside and outside on electrically driven reamers and polishers.

After being driven into place in the drums, the tubes are bell-mouthed or flared, by the use of an air machine which drives a rapidly revolving, tapering tool into the end of the tube. It often happens that some tubes are too long, and these must be cut to the right length, burred, and re-rolled or expanded.

Finally, all seams are calked, the fittings are attached by machinists, the manhole plates are fastened on, and the boiler tested to about four hundred pounds hydraulic pressure.

The boiler factory also builds condensers, smokestacks, expansion tanks, and feed, filter, and fresh-water tanks, but the operations do not differ greatly from those used in making boilers.

Outline of the Trades and Operations in a Typical Boiler Shop

1. *Acetylene or oxyhydrogen men.* Operations are similar to those in other work on steel. One operator in the shop and one on outside work.

2. *Carpenters.* One carpenter (a millwright) sets up blocking

for boilers to be erected, repairs overhead connections for machinery, and does other rough work about the shop.

3. *Blacksmiths.* Bend all angle irons used as bands for forced-draft boxes, uptakes, and smokestacks. Do repair work for the shop. Two smiths and a helper.

4. *Loftsmen or layer-outs.* Develop all plans; mark material; make wooden or metal templates if necessary. One or two experts and a helper.

5. *Flanging machines.* Flange front and back heads, furnace holes, combustion chamber heads, and various small pieces of different shapes and radii. One or two skilled flange turners and three to seven helpers.

6. *Machinists and skilled mechanics.* Assemble and attach fittings to boilers or tanks; operate radial drill, shell drill, bolt-cutting machine, planer, boring mill, drill press, horizontal and vertical rolls, punch, shears, various air and electrical machines (reaming, calking, drilling), and hydraulic riveter. Install boilers, stacks, and tanks on the ships. Much of this work is done by unskilled help, or can be readily taught to men of average mechanical ability.

7. *Crane men and riggers.* Two or three crane operators and several riggers to attach chains and ropes to objects to be moved. Similar to crane work in other parts of the yard.

8. *Unskilled labor.* Polishing, bending, inspecting, cutting, burring, and trucking tubes operate drill presses; machinists' and boiler-makers' helpers; assembling casings (as helpers); carrying material; sweeping and cleaning.

A few boiler-makers learn their trade through apprenticeship, but the customary practice is to promote capable helpers. It is possible to divide the work in such a way as to have much of it done by men of only slight experience in boiler-making. Helpers soon become able to do second-class work and in most shops promotion is likely to be quite rapid. The work requires strong, able-bodied men who are willing to do hard, heavy work. Very little education is necessary, although the ability

to read blue-prints and perform ordinary calculations is helpful.

Trained boiler-makers are difficult to secure. Most shops depend upon hiring blacksmiths, machinists, carpenters, and other mechanics who are capable of doing heavy work.

The work of blacksmiths in a shipyard does not differ materially from that done in any large shop connected with the manufacture of machinery. They forge many machine parts and various sections of the ship, such as crank shafts, eccentric rods, struts, truss rods, brackets, and a variety of ship-fittings. Drop forging is used in making hinges, eye bolts, and ship-fittings. Most shops are equipped to handle anything that can be made from billets up to ten tons in weight. A large amount of the work is done with steam hammers and very large forging presses.

A typical equipment in a blacksmith shop of a shipbuilding plant consists of steam hammers, pneumatic hammers, oil furnaces, large coal furnaces, small coal furnaces (or fires), shears, anvils, tongs, dies, sledgehammers, hammers and other small tools, and cranes for handling large work.

Much of the work is done on special grades of steel, which are more difficult to work with than soft steel or iron.

The repair and tempering of tools for workmen throughout the yard is an important feature. From six to twelve men are usually employed in a large yard in making dies for the power hammers used in drop forging.

In addition to being very heavy, most of the work must be accurately done. Men who have had all-round experience in a country blacksmith shop, or wagon-makers,

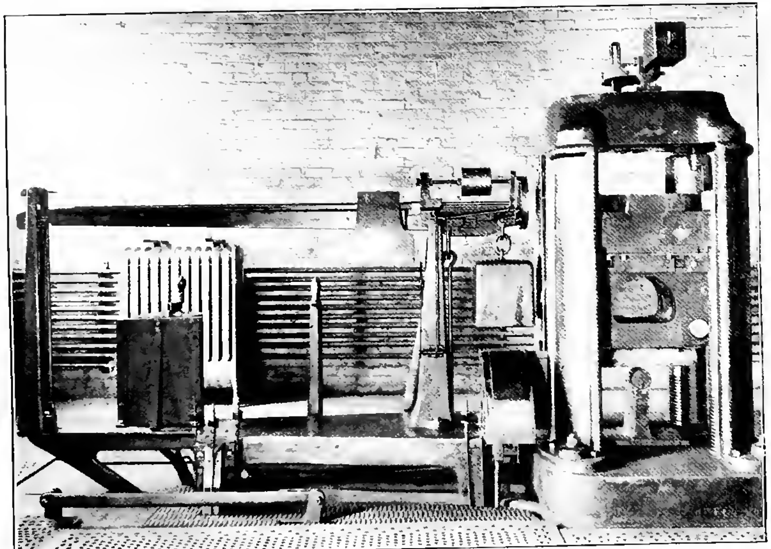
do very well. Those who have done light work, such as horseshoeing, are not likely to find shipyard work easy. Men accustomed to the operation of steam hammers, provided the work is done with a fair degree of accuracy, can readily take up the trade here. Helpers must have experience in keeping fires and striking.

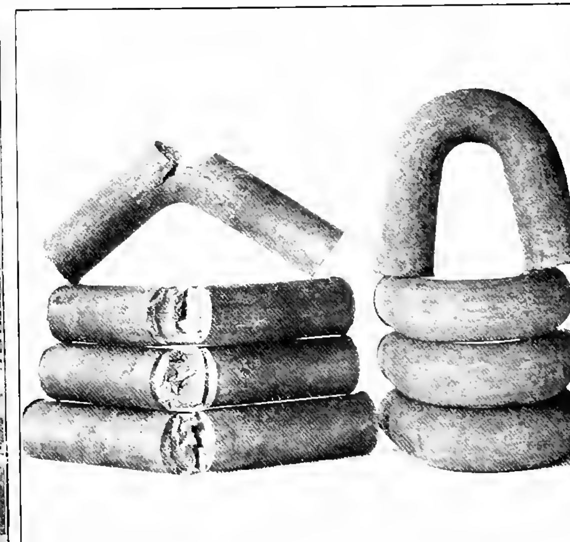
Mechanics are developed from helpers. They are started by being given a forge and a helper to do simple work. In the course of a month or two, an alert man is usually able to do almost anything required of him. Boys who wish to learn the trade should be eighteen or nineteen years of age, well developed, and willing to do hard, heavy work.

Very few blacksmiths understand how to read blueprints. Foremen may have to make detailed sketches, or wooden templates, for complicated pieces.

The machinist's trade forms a large and exceedingly important part of shipyard work. There are two main divisions of the trade, namely, shopwork and that done by outside machinists who install the machinery on the ships.

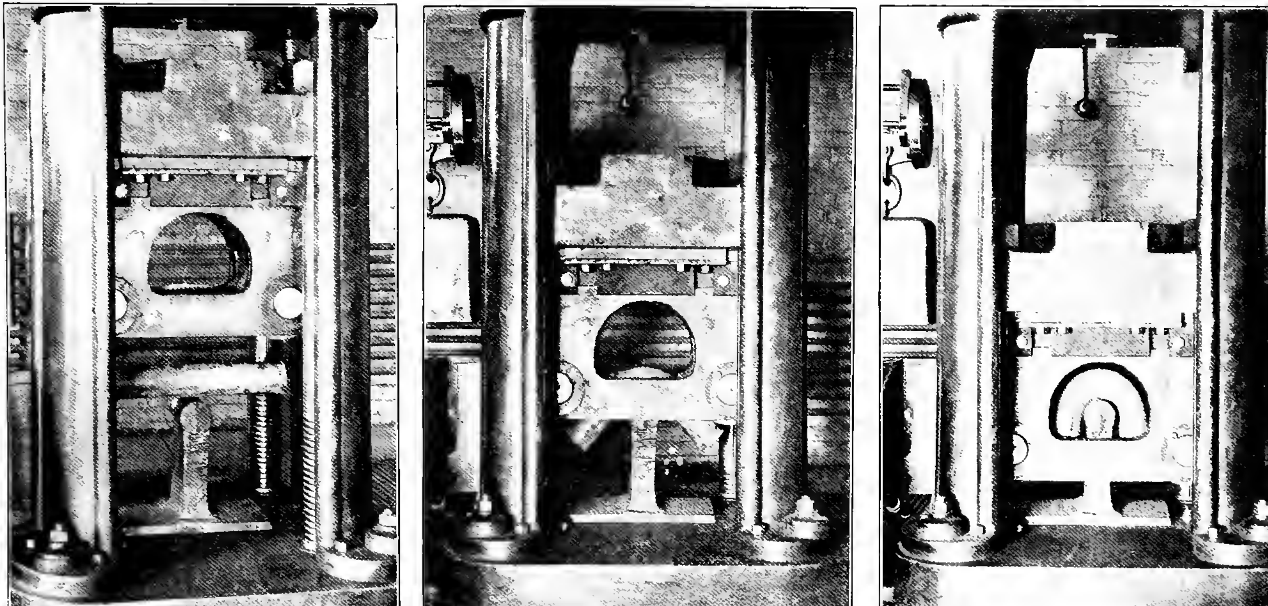
The shops build reciprocating and turbine engines, propeller shafts and propellers, and fittings for boilers, motors, and pumps. A great variety of parts for the hull and superstructure are drilled, machined to size, and fitted, such as manholes, scuttles, mast fittings, deck hoists, windlasses, turrets, ammunition hoists, air ports, and gratings. From one third to one quarter of the men in the shop are employed in fitting and erecting machinery; the rest are employed at bench and machine operations. A number of men are always engaged in making and sharpening tools. Some special work is done for other shops and other divisions of the yard.





METHOD USED IN TESTING THE IRON USED IN ANCHOR CHAINS FOR THE GOVERNMENT NAVY YARDS

A number of large companies outside of the yards are engaged in manufacturing machinery and miscellaneous material for use in shipbuilding. All of the material used on government contracts is subjected to rigid tests



THREE STAGES IN THE TESTING OF IRON FOR ANCHOR CHAINS

Much of the work requires very large, heavy tools. Boiler plates, propellers, shafts, rudders, and many of the turbine and reciprocating engine parts are extremely large and require special machinery.

Ship construction requires a great many more brass parts than are to be found in ordinary machine construction. A few parts are also made of aluminum and other metals.

The machinery and tools in use in the shops differ very little from those used by any modern machine shop. A few large-size planers, boring mills, and slotters for extra heavy work are the only tools with which an experienced machinist would probably not be familiar. The following list of machines and classes of work is typical of what one is likely to find in any large shipbuilding plant.

Classes of Work and Operations found in a Shipyard Machine Shop

1. Bench work (filing, snagging castings, etc.).
2. Floor work (erecting and assembly).
3. Hand milling.
4. Engine lathe.
5. Plain and universal milling machine.
6. Vertical milling machine.
7. Horizontal and vertical boring mills.
8. Shaper.
9. Planer.
10. Screw machines (hand and automatic).
11. Turret lathe.
12. Universal grinder.
13. Tool cutter grinder.
14. Slotter planer (like a vertical planer, used for cutting large gear teeth and other vertical work).
15. Shrinking brass sleeves on propeller shafts.
16. Lay-out table.
17. Testing.
18. Niles crane (1 fifty-ton, 2 twenty-five-ton, 2 ten-ton cranes in use).

19. Riggers (floor men who fasten ropes from crane to machinery or parts to be moved or lifted).
20. Oxy-acetylene welders and cutters.
21. Tool-room men.
22. Office force.
23. Sweepers.

Outside machinists install and test the engines and other machinery on board the ships. Men are usually advanced to this department from assembly work in the shops. First-class machinists with a good knowledge of ship construction are required for the leading positions. About half of those engaged on outside work are helpers or second-class machinists.

The three most important divisions of this work are as follows:

1. The installation and testing of engine-room machinery such as main and auxiliary engines, pumps, piping, propeller shafts, and propellers.
2. The attachment of fittings to the hull including valves, sea-chests, etc.
3. The installation of deck machinery, capstans, winches, and steering gear.

Among the trades from which desirable workmen may be secured are the following: erecting-men on gas or steam engines, turbines, or machine tools; millwrights; automobile and gas-engine assemblers or repair men; erecting-men on steam boilers; elevator constructors. The outside machinist is one of the most important workmen in the yards and at present it is impossible to supply the demand for skilled men. It is especially difficult to find enough men for outside shipyard work who are experienced in erecting and installing heavy machinery such as that used in paper mills or locomotive works.

In former times, when it took from one to five years to complete a large ship, there was no need for so many mechanics in this trade. There was ample time for a small gang of men to do all of the work that was necessary. Emergency construction, however, calls for a very different programme. Director-General Charles M. Schwab, of the Emergency Fleet Corporation, has repeatedly called attention to the necessity for speeding up the production of propelling and auxiliary machinery. Due to the better distribution of material and the rapidly increasing supply of fabricated steel, the hull work is outstripping the production of engines, boilers, and other machinery. According to Mr. Schwab, there is already fair provision for the manufacture of boilers, but the shops for producing engines and auxiliary machinery will need to be greatly enlarged. This, of course, means an added demand for machinists, and especially for erecting- or assembly-men.

The shops need especially planer hands and lathe hands to machine large castings and shafting, vertical boring-mill hands who can do cylindrical boring, and horizontal boring-mill hands capable of milling engine frames and boring bearings. Men who have been employed in railroad shops or in making large machinery such as printing presses have had the type of experience most needed. There is a constant demand for tool setters, tool makers and grinders, and especially for all-round machinists who can assemble and install machinery.

Young men who desire to learn the trade should have a good knowledge of the use of blue-prints if they hope to advance rapidly. Technical-school graduates or high-school boys who have had shop practice and mechanical drawing have had good training for this work and may

reasonably expect to make good progress. In ordinary times many of the men learn the trade through apprenticeship. An apprentice gains at least three or four months' experience on each of the following classes of work: Bench work; laying-off table; small machines, as lathe, slotter, shaper; large machines, as lathe, planer, boring mill; assembly and repair; repair of air tools; outside work erecting machinery on the ships.

It is customary to employ a large number of men who are unskilled as helpers. Any machine-shop experience, or experience in any line which involves the handling of tools or the reading of blue-prints, is helpful in gaining promotion. Helpers are put on some simple operation of assembly or bench work, or they assist machine operators. Capable workers are soon advanced to machine operation and are able to command good wages.

The work varies constantly in all shops, very few duplicate parts being made. On this account day rates and contract work instead of piece-work prevail in most cases. Day rates apply to handy men, helpers, and a few machine hands, while the rest, probably seventy-five per cent of the total, are on a contract basis.

It is necessary to galvanize ship-fittings and certain castings and forgings exposed to sea air and dampness, to prevent corrosion. Galvanizing consists in covering the surface of the metal with a thin coating of zinc. Among the fittings which must be protected are the following: Guard rails and stanchions, cooking rims, covers and gratings, ladders, lockers, such articles as basins, troughs, and racks in washplaces, mess racks, and fittings on mess stools and tables. Many of the structural parts of torpedo boats and destroyers are galvanized.

The process of galvanizing has two main divisions —

A MACHINIST AT WORK ON A SLOTTER, OR MILLING MACHINE

Cutting a slot in the flange of a turbine rotor shaft

cleaning, and coating the parts with zinc. After burning off the paint or oil and cleaning with wire brushes, the castings are immersed in tanks containing hydrochloric acid and water. Coating with zinc is accomplished either by placing the parts in a hot zinc solution or by an electric process.

The work is done in a building quite open to the weather, so that the fumes of the solutions used may readily pass away on the air. There is usually a series of three or four long, narrow tanks of concrete or masonry, with derricks swinging overhead capable of carrying the heaviest fittings. A variety of baskets and special hooks are used for holding and handling the material to be treated.

This department calls for one or two expert galvanizers and a considerable number of unskilled helpers or derrick operators and handlers of parts. There may be five or six helpers to one expert. Foremen in this work usually learn the trade through practical experience. They must know how to make the bath solutions and how to handle and dry the parts treated. Really capable men who understand this work are hard to find, but the actual number needed in the yards is not large.

Steel plates as received from the mill have a scale which must be removed before they can be painted or cemented. If this is not done, bare spots are left when the scale falls away. The plates are cleaned by standing them on end in a weak solution of sulphuric acid for about twelve hours. They are then dipped in lime water, thoroughly washed with clear water, and dried. The process is commonly known as "pickling." Boiler plates are an example of material which must be treated in this way. The work is all heavy labor, requiring no special skill, or experience.

The sheet-metal shop manufactures a variety of articles from sheet iron and tin. The greater part of the work is on metal less than three eighths of an inch thick. Among the products of the shop are the following:

Tanks, ventilating systems, lining boxes, lockers of all types, wire work, boiler and engine lagging, insulation on the sides of ships, corrugated bulkheads, exhaust and intake headers, fuel oil tanks, dish racks, and ventilating cowls of the Turk's head and mushroom types.

Each piece is made up from blue-print specifications prepared by the drafting department. In most cases a leading man from the shop takes such a drawing to the ship and checks the location of each part against the drawing. After this, he gives the drawing to a layer-out, who makes a paper template and marks out the work on the sheet metal. The mechanics then cut out the metal forms, do such drilling or punching as may be required, bend the article into shape, and rivet, solder, or weld the seams. This work is constantly checked by the leading man or foreman as the work progresses.

A typical equipment in a sheet-metal shop consists of brakes, rolls, shears, punches, beading machine, flanging machine, combination angle shear, Smith's quick worker or rotary cutter, hydraulic press, electric spot welder, wire crimper, wiring machine, drill presses, lathes, and shapers.

A considerable number of the men in this trade are engaged part or all of their time in the work of installing on the ships the articles made in the shop.

First-class sheet-metal men should be able to read blue-prints, and ought to be acquainted with the common processes in arithmetic, namely, fractions, decimal fractions, and mensuration. They should be able to lay out

patterns when required, should be thoroughly conversant with all the machines and tools common to the sheet-metal trade, and able to complete any ordinary piece of work.

The second- and third-class men should be able to read blue-prints, use patterns or molds already made, and make up the less complicated work, such as pipes, tanks, and elbows. Helpers who are capable and anxious to learn can in a few months become second- or third-class mechanics.

Any sheet-metal worker, tinsmith, corrugated-iron worker, or heater and range man can readily adapt himself to this work. All first-class sheet-metal workers are recruited from the ranks of helpers.

Shipbuilding requires the use of a great deal of copper and lead for pipes and other articles which must be protected from the corrosive action of sea-water or other influences having a like effect. Coppersmiths in the shipyards make in the shops and install on the ships a great variety of copper pipes and connections. These include among others copper and brass pipes and fittings for the main and auxiliary steam connections, and pipes for discharge exhaust, fire mains, and bilge suction. As a rule, these pipes are from two to five inches in diameter, but may be as large as thirty-five inches in diameter. Much of the work requires considerable physical strength and endurance since it involves the use of heavy hammers in shaping the pipes. Material up to one half inch in thickness may be used. The larger yards employ from thirty to sixty coppersmiths and helpers. The following description indicates the general nature of the work done in this department:

A blue-print is furnished the shop, showing the dimen-

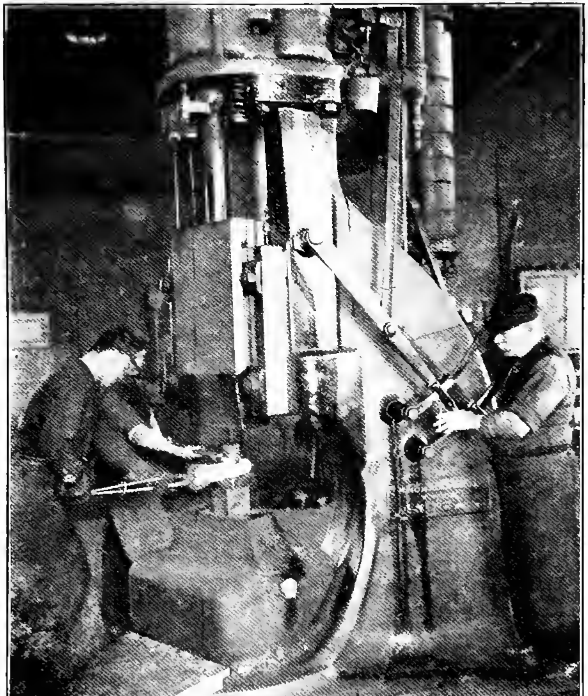
sions and shape of the pipe or fittings to be installed. Flat copper pieces are cut, according to the size of the piece to be made, and roughly shaped, as indicated by the blue-print. The coppersmith then goes to the ship and plans, from the surfaces to which the pipe must be attached, a wooden template upon which the pipe can be constructed in the shop. For small pipes this wooden form is not necessary. They are bent in the shop and fitted directly to connections on the ship. The large pipes are fitted to the template in the shop, the necessary connections are attached, and the flanges are brazed or riveted on.

Conditions vary greatly in this trade in the shipyards. Some shops do practically all the work by hand, while others have installed a considerable amount of modern machinery. The following is a representative equipment in a shop using machine tools:

Rotary shear, hydraulic up-setting machine, bending rolls, upright drill, pipe-filling tanks, band-saw, laying-off table, punch, pipe expander and bending machine, power hammer, and gas and oil burners for brazing.

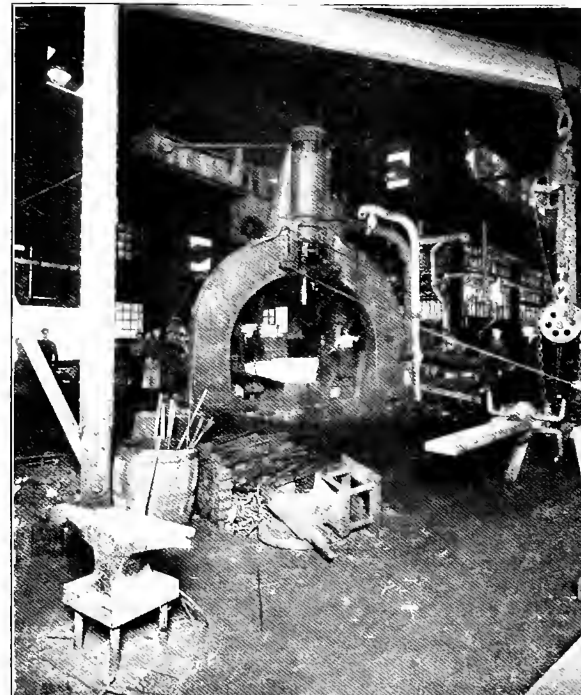
The final operation usually consists in installing the parts on board the ship. This work is frequently done by the regular pipe-fitters or plumbers instead of being required of the coppersmith.

A few of the yards have apprentices in this trade, but as a rule only mature men are wanted. Except in the shops under strict union regulations, nearly all first-class coppersmiths are developed from helpers. Each skilled man has at least one helper, sometimes two. Experience in any coppersmith shop on work in copper pipe and sheet copper is usually sufficient to enable a man to carry on all the operations required in a shipyard. Silversmiths,



BLACKSMITHS OPERATING A STEAM HAMMER

In addition to being very heavy, most of the work must be accurately done. The blacksmith shop forges machine parts and ship-fittings up to ten tons in weight. Tools throughout the yard are repaired and tempered



FORGING A PROPELLER-SHAFT

Much of the work in a shipyard blacksmith shop is done with very heavy steam hammers and forging presses

sheet-metal workers, tinsmiths, and workers on certain operations in a boiler factory have had experience of a desirable kind. The principal difficulty lies in making and fitting exceptionally large pipes and in learning to work from templates instead of from blue-prints. As a rule the templates are very simple and it does not take long to master their construction and use. Experienced men are started on first-class pay as soon as they can demonstrate their ability.

Probably no branch of shipyard work is so short of skilled mechanics as coppersmithing. It has been stated on good authority that probably ten more ships could have been launched on July 4, 1918, if enough coppersmiths had been available to install the piping. At present the majority of the men in this trade are of foreign birth. In one of the yards visited by the writer, over ninety-five per cent of the coppersmiths were born abroad, Russians and Italians being most numerous.

In addition to the work done by coppersmiths, there is a large amount of general plumbing and pipe-fitting which is in charge of the pipe shop. On the ships the pipe shop installs heating and sanitary systems, bilge and ballast piping, steering gear, windlasses, scuppers, drains, fire extinguishing systems, air ports, turrets, magazines, and ammunition hoists. The plumbers make the joints for most of the copper pipes and install much of the shorter piping.

Although plumbing is an important branch of shipwork, it is relatively small in comparison with the work done by pipe-fitters. There is much more heavy work than in house plumbing and considerably more bending of pipe. Very few factory prepared pieces are used. On account of the corrosive action of sea-water, the ship

uses a great deal of lead pipe and much sheet lead, as in the floors of shower baths.

A shipyard pipe-fitter must know how to bend his pipe, how to use lead ends, wipe joints, and install his work. It is important for him to realize that his work has to be fitted in such a way as to take care of the movement of the ship. Decks and bulkheads must be water-tight, and wherever pipes pass through them, or traverse water-tight compartments of the ship, extreme care must be taken in the installation.

Some of the work done by this department is of a highly specialized character and requires workmen who are thoroughly familiar with the peculiar demands of ship construction. Turrets for battleships are of this character. It may require as much as a year to install a turret with its track, ammunition hoists, and placements for guns on a large battleship.

In the yard itself, a special gang of twenty to forty men is required to lay and repair all steam, air, gas, and water pipes, and to care for the plumbing in buildings. A few plumbers and steam-fitters having good general experience are needed; the rest are unskilled workmen.

A yard employing a total of eight thousand men has about three hundred men on this class of work. They are grouped as follows:

Plumbers — fourteen men employed. Men who have had experience in pipe work on railroad cars have had valuable experience.

Pipe-fitters — fifty men employed. Install all galvanized iron pipe. They must bend and joint up pipe. In many ways their work is similar to that of the mechanics who lay electrical conduits on the ships. (See page 183.)

Machinists — sixty men employed. These men must

have had experience as pipe-fitters. As a rule any good floor hand who knows how to lay off and install his work can be used.

Chippers — thirty men employed. Use air and hand machines to smooth up pipe and castings in various parts of the work.

Drillers — thirty men employed. Air and hand machines.

Pipe Machine Men — four or five employed. Cut and thread pipes in the shop. This work is not highly skilled, and helpers are advanced to these positions.

Helpers — one hundred and forty to one hundred and fifty men employed. No previous experience is necessary.

Only a small portion of the work is done in the shop, nearly all the men being constantly employed on board the ships or about the yard. Employment is steady and the pay is regular, conditions which do not always exist for outside plumbers. Excellent experience will be gained by any man who expects to return later to his former employment, since many parts of the shipwork call for a high degree of skill and there is constant change in the nature of the parts to be installed. Every pipe-fitter and plumber requires a helper; a man with little or no experience can be used for these tasks. It usually takes from two to three years for a helper to learn the trade.

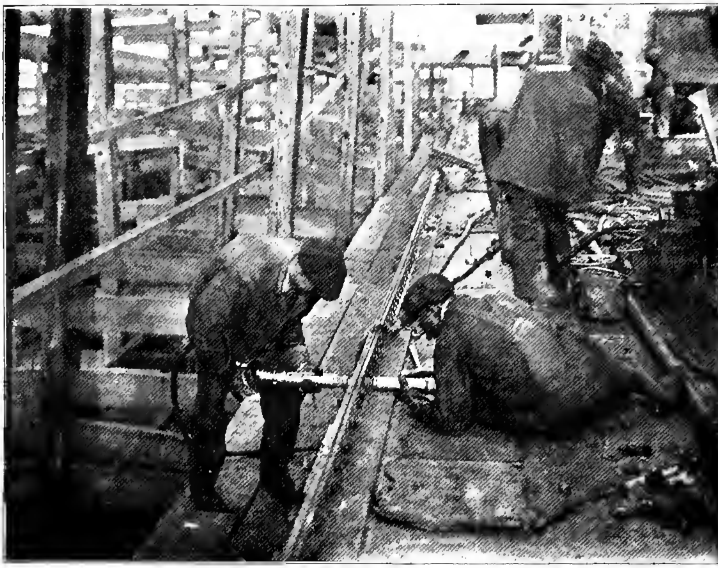
Men who have had experience in railroad work on car plumbing are especially well fitted for this department. Any plumber who has had experience on sanitary installation or who fully understands pipe- and steam-fitting can soon advance to a first-class rating. Apprentice courses for this work are well developed and many boys enter the trade in this way.

The processes of oxy-acetylene cutting and welding

depend upon the fact that a combination of acetylene gas and oxygen burned under certain conditions produces a temperature of about 6700°. By the use of the blowpipe the effect of the enormous temperature is localized and metals can be oxidized and blown away while an eighth of an inch distant the metal remains unchanged. This is applied in welding by using a modified heat, and less oxygen, sufficient to render molten the immediate locality of the weld, but insufficient to disintegrate it.

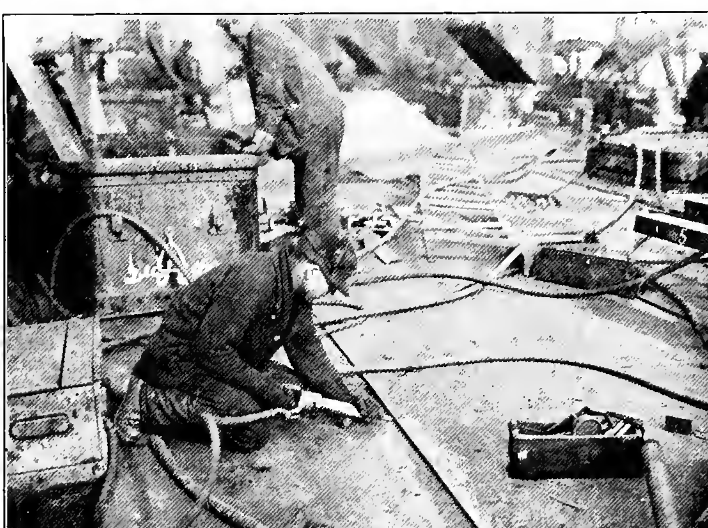
Briefly stated the processes are as follows: A tank or cylinder containing about 100 cubic feet of free oxygen under a pressure of 1800 pounds per square inch is connected through fittings to a reducing valve and tube. Similar connections are provided for a second tank containing acetylene gas. A tank of compressed acetylene gas at 225 pounds pressure contains about 150 times its own volume of gas. Acetylene gas compressed in a tank above 30 pounds per square inch is highly explosive. To prevent the possibility of explosion the tanks are packed with a porous asbestos fiber preparation. The asbestos-filled tank is then charged with liquid acetone to about 40 per cent of the volume of the tank. Acetone has the property of dissolving twenty-five times its own volume of acetylene gas for each 14 pounds pressure, thus rendering the cylinder absolutely safe.

The tubes from the oxygen tank and the acetylene tank are connected to a blowpipe or welding torch which consists of a tip having an opening that controls the size of the flame and a mixing chamber, with a shut-off valve for each gas. In welding, the metal is first prepared by making a V-shaped cut and heating the part to take care of expansion. When the vicinity of the break has been rendered molten, flux is used to assist in the bending and



RIVETING WITH TOOLS DRIVEN BY COMPRESSED AIR

The gang usually consists of the riveter (shown on the left), the holder-on (on the right), a passer, and a heater. The passer may be eliminated.



CALKING, OR MAKING WATERTIGHT

This work is done with an air-driven tool somewhat like the riveting gun

prevent oxidization and a stick of metal is used to build up and add to the metal removed. When complete the part is allowed to cool slowly to prevent cracking. The treatment varies with the various metals and the sizes of the parts.

The cutting torch is slightly different in that a jet of oxygen is provided for in addition to the heating flame. The work to be cut has the usual flame played upon it for a few seconds until it is glowing, when a jet of pure oxygen is added which has a rapid oxidizing effect in the presence of the heat and the metal is literally burned away in a shower of sparks. Cuts may be made up to nine inches in depth. The width of cut in one fourth inch steel plates can be reduced to one sixteenth of an inch. On deeper cuts the width increases up to a maximum of half an inch.

These processes are of very great importance in all shipyard work. They are used to advantage in the foundries, steel mills, machine shops, boiler factories, and sheet-metal shops, as well as by various workmen engaged in hull construction or in the installation of machinery on the ships.

In preparing steel plates for bulkheads, for example, a great deal of cutting is done in making numerous large, irregular openings in the plates to reduce their weight. As much metal is removed as possible while still retaining the necessary strength and rigidity for the bulkhead. Both cutting and welding have important applications to marine repairs as well as to shipyard construction.

The trade offers well-paid employment at clean, interesting tasks. From three to four months are required to master thoroughly the various details of both cutting and welding, but enough experience can be acquired in a

much shorter time to enable an operator to command good wages.

Two methods of joining metal surfaces together with electricity are in common use, spot welding and welding with the electric arc. The electric spot welding machine is used for much the same purposes as riveting. It fuses together, patches, or builds up mild steel, cast iron, bronze, and other metals. The pieces to be joined together are placed between two copper jaws which act as electrodes. When the metal parts are brought together between these jaws and the electric current is turned on, the metal at the point of contact comes to a welding temperature. The pieces of metal are then forced together forming a joint. Larger sections of metal are joined by means of the electric arc. In this process one electrode is placed in contact with the plates to be welded while the other is held sufficiently close to the seam to form an electric arc. The heat of the arc quickly brings the metal parts to a welding temperature. By slowly passing the electrode along the seam, the whole length of the plate can be welded. Water-tightness is secured by going over the surface of the weld while hot with an air-driven calking tool.

An interesting application of this method of welding was made in the repair of the interned German and Austrian vessels which were taken over by the Federal authorities when war was declared in 1917. In order to render the ships unfit for service, extensive damage had been done to the engines and boilers by the German engineers. The most important breakage was to cast-iron cylinders, the casing of turbines, and to the tubing and fittings of boilers. In making the repairs, electric welding was used throughout, the chief advantages being

that no preheating of the parts or removal from the ships was necessary. So successfully was this work accomplished that none of the ships was delayed in being put into service beyond the time required to overhaul them and equip them as transports. Thus by the use of electric welding all were able to put to sea as quickly as though no damage to the machinery had been done.

There are two principal divisions of electrical work in the shipyards:

1. The installation and repair of motors and electrically operated tools throughout the yard. This division includes the wiring of buildings for power and light and the upkeep of these systems.
2. The installation of electrical machinery and power and lighting systems on the ships.

The newer steel ships and submarines require a great deal of electrical wiring and electrical machinery. There are lighting and power circuits, electric search-lights, wiring for gasoline motors and generator systems, and a variety of motors. The following is a partial list of motor installations on warships:

Boat cranes.	Steering-gear motors.
Deck winch.	Motors for turning turbines.
Ammunition hoist.	Turret-turning motors.
Ventilating fans.	Gun-elevating motors.
Fresh-water pump.	Anchor windlass.

Storage batteries, wireless outfits, and a few other units are usually installed by the manufacturers.

Yard repairmen ("trouble shooters") care for all motors, light and power lines, switchboards, etc., throughout the plant. Nearly all the machinery in the shops is motor-driven, the cranes are operated by electricity, and there are numerous power and light lines that may get

out of order. Each large shop usually has one man in charge of all motors. In the case of the smaller shops, one man may have charge of this work in two or three different shops. It is his duty to inspect and to make any ordinary repairs on motors and electrical wiring and to install any new machinery. Men who are familiar with machine operation and repairs are usually selected for such work. Men from the shops who are familiar with the yard are often advanced to these positions. A so-called "trouble shooter" or maintenance man from a locomotive works has the type of experience desired.

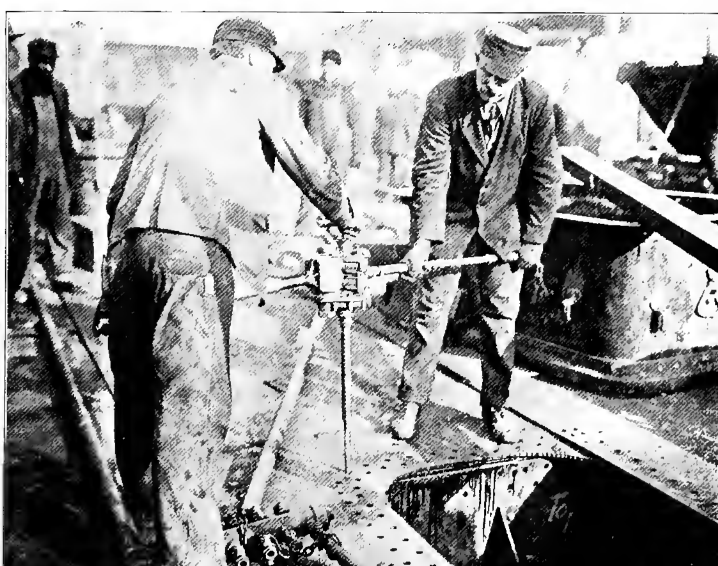
Two or three men are employed in each electrical shop as machinists and armature winders. Most of their work consists in repairing electrical appliances from the yard, rewinding damaged motors, building switchboards, truing up commutators, and other machine work. An occasional second-hand motor is purchased which must be put into good condition.

These men need an all-round electrical experience and must in addition be skilled mechanics, accustomed to the use of ordinary machine-shop tools, such as the lathe, drill, and planer. At least two or three men are always kept in a shop who are familiar with the operation and repair of hand tools. They repair and carry spare parts in stock for all motor-driven drills, reamers, or other small tools.

As soon as the hull is complete and enough of the inside finishing has been done by the joiner shop, a gang is sent to the ship to do the necessary wiring and installation of electrical machinery. Each gang is furnished with a set of portable benches, the necessary tools, and a certain amount of wire and conduit. All the wiring on the ship except around generators, at switchboards, and in

OPERATING AN AIR DRILL

A special rig, or "hook stick," is used to steady the drill and exert enough pressure to force it into the steel plate



A HEAVIER DRILL REQUIRING TWO OPERATORS

Drilling, reaming, chipping, calking, and riveting are usually done on a piece-work basis. "Counters" are employed to estimate the amount of work done by each gang

wire tunnels, must be enclosed in conduits of enameled steel, enameled brass, or flexible, rubber-lined hose. The steel and brass enameled conduits are similar to standard steam, gas, and water pipes.

The electric pipe-fitter differs from the plumber in the character of the bends and joints to be made. The conduit layer must make all bends on a very long radius instead of right-angled elbows of the kind used in plumbing. Otherwise it would be impossible to run the wires through the conduit after it is installed. The steam-fitter or plumber very often screws joints together until the ends meet, thus forming a burr of metal across the connection. Such a broken piece of metal would prevent the entrance of a wire, but would not affect the pipe in carrying water or steam. Steam-fitters usually bend pipes while they are hot, while conduit men are expected to bend pipe up to two inches in diameter while it is cold.

Bell-hangers are men who install mechanical telegraphs, battery circuit work, and telephones. The work is very similar to that done by telegraph and telephone electricians.

The storeroom is usually under the control of the Materials Department. About three men act as stock clerks. They check up requisitions for material and keep account of stock.

Four to six men may be employed as oilers in a large yard. They oil and inspect all motors in the yard, calling a trouble man if necessary. Helpers without previous experience can be trained in one to three weeks.

Experienced electricians will find a number of points with which they must become familiar before they can be really efficient on shipyard work. Among them are the requirements of Lloyd's code and the underwriters' code

for merchant ships, Government specifications for Federal work, new methods of installation such as are required on water-tight joints, and the connections for complicated telegraph and telephone systems. Experience in house wiring is helpful, but shipwork must be done very much more carefully since it is all exposed. Most workmen are expected to do conduit work as well as wiring.

First-class electricians are relatively few in number, the bulk of the work being done by second-class men and helpers. The modern plan of operation is to place a foreman in charge of a ship or a group of ships. He must be familiar with the installation, construction, and operation of generators, motors, and switchboards and the installation of conduits and wiring. Under such a man, several gangs of men will be found, each doing its own special kind of work. The gang may be made up of one electrician, four or five helpers, and one or two apprentices. Sometimes two men make a gang; often one man will work alone on a specialty. A gang may specialize on any one of several kinds of work, such as installing motors or generators, connecting up motors, interior communication, lighting systems or power circuits.

Any man who learns to do electrical work well on a ship is certain of good pay and reasonable promotion in work outside of the yard. Furthermore, the yard offers many opportunities to gain an acquaintance with a variety of mechanical work. The electrician touches elbows constantly with painters, steam-fitters, machinists, carpenters, and inside finishers. Apprentice courses are usually well developed in this department and it offers excellent opportunities to young men who wish to learn the trade.

REQUIREMENTS FOR ELECTRICIANS

The pay varies according to the skill of the workman and the class of work being done. Helpers are advanced fairly rapidly. In order to become first-class electricians, men must understand how to read blue-prints and be capable of laying out and completing a piece of work.

CHAPTER VIII

THE WOODWORKING SHOPS AND YARD MAINTENANCE

THE building of steel ships is not all done by men who work in metals. In Chapter VI we have described the important part played by the shipwrights or ship carpenters in laying the keel blocks, erecting the scaffolding about the berth, keeping the hull "fair" or trued up as it is built, and in constructing staging for the riveters, painters, and other workmen inside the vessel. Besides these men who work in wood, there are the pattern-makers who provide the patterns for the metal parts cast in the foundry and the joiners who build furniture and finish parts of the interiors of ships.

It is surprising to discover how much woodwork is to be found in a ship which to the casual observer appears to be entirely of steel. Staterooms, the pilot house, storerooms, refrigerators, and cold-storage rooms are all usually finished in wood. Decks, gratings for kitchen and pantry floors, lockers, and furniture may all be of wood. On some of the newer steel ships the pilot house and its fittings are largely of brass and much ship furniture may be of steel, but this still leaves much important work for the joiner. Rooms that come so near the boilers or engines as to be uncomfortably warm are insulated with asbestos and cork. In frosty weather moisture gathers on the metal parts of the ship, making it necessary to sheath lockers, seats, and walls with wood to prevent clothes and other articles from being spoiled by contact with them. Even in the construction of freight steamers,

A MEMBER OF THE YARD MAINTENANCE DEPARTMENT

Thousands of unskilled laborers are needed in the shipyards. They handle materials, keep the yard and ways clear of rubbish, and are employed as helpers in many kinds of work

REAMING WITH AN AIR-DRIVEN TOOL

Where the holes in the plates do not come exactly opposite each other, or "fair," they must be enlarged to take the rivets

there is much important work in wood, and in building passenger vessels, where more attention is given to furniture and interior decoration, there is a correspondingly greater demand upon the joiner shop.

The woodworking departments offer excellent opportunities both for young men seeking to learn a trade, and for experienced pattern-makers, carpenters, mill men, and cabinet-makers who wish to find employment in the shipyards. The shops visited by the writers have all been clean and well lighted and ventilated. Conditions on the whole are very much better than those in most of the metal trades. As a rule, the majority of the workmen are of American birth. Some idea of the number of men engaged in these occupations may be gathered from the statement that more than 1400 men were found in the woodworking trades in five yards employing a total of about 19,000 employees.

In some yards a rough distinction is made between ship carpenters and joiners on the basis of the size of lumber used. Ship carpenters do all work on lumber over two inches, both inside and outside the ship. The greater part of the material which they handle is rough, heavy timbers and planks. The joiners build and install furniture for staterooms and storerooms, do the inside finishing of these rooms and the pilot house, construct decks less than two inches thick, fit up the carpenter's workshop for the ship, build accommodation ladders and all wooden stepladders or stairways, make spruce and ash gratings for floors, and build doors, refrigerators, and equipment for cold-storage rooms. This shop also builds tables, desks, chronometer cases, and lockers. Some work is done for other departments and shops in the shipyard. Much of it is rough jobs, such as building of bins or

shelves for storage, which can be done by third-class men.

The various divisions of the work done in connection with a typical joiner shop are described in the following sections:

1. *Drafting-room.* The work of this division requires from one to three first-class joiners and one or more apprentices. When the blue-prints come from the hull drafting-room they show only the location and approximate size of the articles to be built. From these blue-prints, complete drawings must be prepared for each important article of furniture or piece of work to be installed, so that it will fit the slope of the deck or the side of the ship. Elevations and plans to one and one half inch scale are made from the detail drawings.

Drawings are not always necessary nor used in practice for all work done by the joiner. On small jobs, the material is laid out from measurements taken directly from the blue-prints or specifications.

2. *Mill work.* The methods and machinery found in this department do not differ in any important way from those to be found in any mill engaged in such work as preparing material for inside house finishing, furniture, or railroad cars. Among the machines used are the following: planer, mortising machine, tenon machine, variety molder (shaper), four-sided molder, bandsaw, crosscut saw, boring machine, and lathe. In some shops, the joiner is required to mill his own stock, but as a rule special men are employed to run the machines.

3. *Cabinet, bench, and ship work.* Workmen on these tasks are expected to lay out their material from a blue-print, cut and fit the parts, and install their work in the same manner as any carpenter or cabinet-maker. Pilot

houses and cabins represent the largest work done. They may be built complete in the shop and hoisted out of the building to a flatcar with a traveling crane. Both in the shops and on the ships, the working conditions are usually excellent. The work is clean, it has enough variety to be interesting, and much of it demands a high degree of skill.

4. *Finishing room.* After the joiner finishes an article, it goes to the finishing room to be painted, varnished, or coated with a special preparation as in the case of wooden battery tanks for submarines. The employees in this department are usually under the supervision of the head of the paint shop and the work is not considered as part of that expected of joiners.

5. *Apprentices.* Only a small part of the force is usually recruited in this way, but the joiner shop offers good opportunities for young men.

The period of apprenticeship varies from three to four years, according to previous experience and training. Boys from industrial schools may be considered well prepared if they understand working drawings and have had practice with the essential woodworking tools and machines. The course is usually about as follows: (1) One year in the shop on odd jobs such as gluing, cleaning, and sandpapering, to familiarize the apprentice with tools and processes. (2) One year erecting on the ship. (3) One year in the shop laying out and finishing different kinds of work. (4) One year in the drafting-room drawing and laying out various details of jobs to be done in the shop.

6. *Grinding tools and repair work.* It is customary in most shops to keep at least one man constantly employed at sharpening tools, repairing tools and machines, and filing saws.

7. *Stockroom and materials.* One man handles all screws, bolts, nails, locks, hinges, and other small supplies. From two to six third-class men and helpers are employed to distribute materials and lumber.

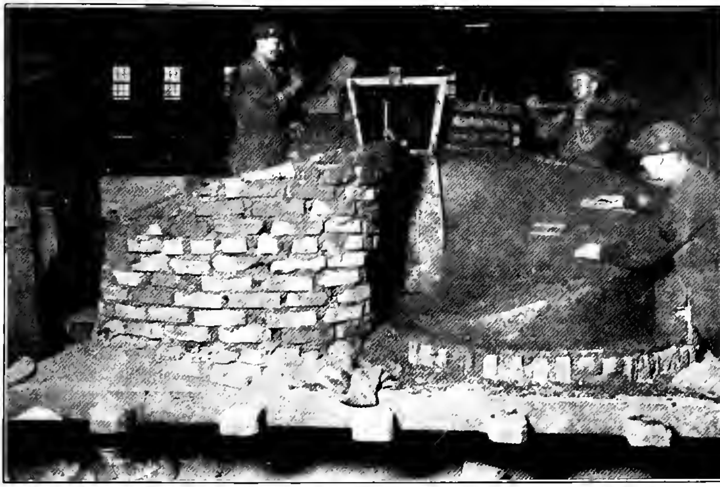
8. *Lumber yard and drying kilns.* Very little skilled labor is needed in these places. Men who have had experience in any lumber yard are capable of handling the work. Most of it is done by unskilled laborers. A large quantity of lumber is handled, even in steel shipyards, for the work of the joiners and carpenters.

Since conditions on the ship are rarely the same for any two rooms, and since they differ widely among different ships, the work of the joiner shop requires much special training and experience. There is a great deal of bevel work due to fitting to the slope of the side of the ship, the camber of the deck, or allowing for machinery, ports, and ventilators. Some of the work is built on a special platform, arranged to conform to the curved surface of the deck. Ordinary carpenters are not used to this kind of work and it takes some time to become fully accustomed to it.

Almost any good mechanic familiar with woodworking tools can break in, but house carpenters, inside finishers, and mill hands make the best joiners. A first-class man is expected to be able to make out a bill of the necessary material from the blue-print, lay out and saw the parts, assemble them, and completely finish the article or piece of work. Speed is an important factor in the amount of pay.

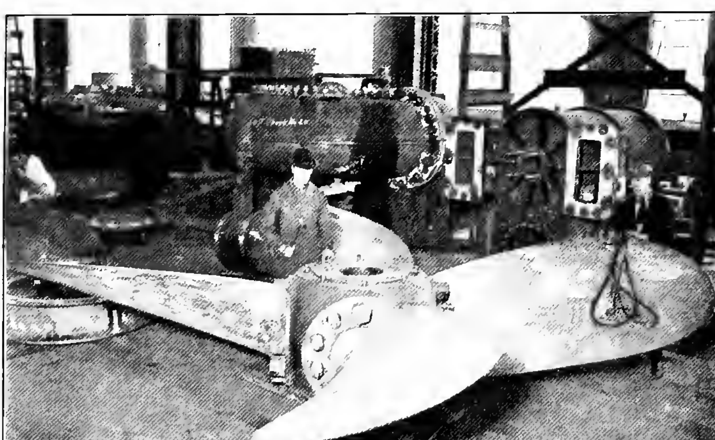
Only a few helpers or handy men are employed in the shops. On the ships, a first-class man may be assisted by several second-class workmen.

The general qualifications necessary for success as a



BUILDING THE MOLD IN WHICH THE PROPELLER IS CAST

Shipyard foundries turn out a great many large castings in steel, red copper, and bronze. The work does not differ greatly from that done in the usual foundry working on heavy machine castings



A FOUR-BLADE PROPELLER FOR A FIRST-CLASS MERCHANT SHIP

joiner may be summarized thus: grammar-school education (high-school education is an advantage); ability to read blue-prints and make ordinary calculations; ability to make working drawings is desirable but not a requirement; a knowledge of practical geometry for purposes of planning and designing; a knowledge of various woods and their characteristics and use in cabinet-work and joinery; a thorough knowledge of and skill in handling carpenters' tools and machine woodworking tools; a general knowledge of ship construction.

In the pattern shop are constructed the wooden patterns from which castings of iron, brass, and other metals are to be made in the foundry. Shipyard methods very closely resemble those used in any pattern shop engaged in preparing patterns for machine parts and structural steel.

Each pattern is a full-sized wooden model of the piece to be cast. The tools are practically the same as those used by other woodworkers, and in many respects the work closely resembles cabinet-making. Ability to read blue-prints is an essential requirement, since the details of each job must be taken from working drawings. Few trades are more interesting or offer a better field for the exercise of ingenuity and originality.

With the introduction of standard models for Government contracts, the number of persons engaged in pattern-making has not increased in the same proportion as in other shipyard trades, but there is still a constant demand for good workmen. A large shop will employ from fifty to eighty men. It may have from five to fifteen apprentices and a few helpers.

All drawings come to the pattern shop complete from the hull or engine drafting room. A small job is done by

one man; a larger one is assigned to a first-class man who will have from one to ten men to assist him, depending on the size of the pattern.

In some cases, a special framework, called a "mock-up," is built to represent the section of the ship for which the pattern is intended, so that a complicated or irregular part can be made which it would be very difficult to describe on a drawing. Struts and casings for turbines are of this character. Patterns for hawse pipes, strainer boxes, sea-chests, or other parts which must fit directly to the hull of the ship are made in this manner to avoid waiting for the hull to be built before the casting is made. In building the mock-up, the lines of the ship are secured from the mold loft templates. In other cases, the work is done from templates or drawings, or is fitted directly to the ship.

The following machines are in common use in shipyard pattern shops:

Lathe.
Bandsaws.
Circular saws.
Jig saws: rip and cross-cut.
Planers: surface and buff.
Sanders for finishing.
Core box machine or core box planer.
Drill.

While work in the shipyards differs in some particulars from that done in other pattern shops, any experienced pattern-maker who is familiar with reading working drawings can soon become accustomed to it. Men from the pattern shops of valve works, electric plants, or locomotive shops often prove quite successful. Because of the great variety of work done, the shop offers an excep-

tionally good opportunity for a young man to learn the trade.

The larger shops carry from five to fifteen apprentices, who follow a well-planned course of training. Boys who wish to take up this trade should have a high-school or trade-school education, or have some knowledge of practical plane and solid geometry and mechanical drawing.

Two men are employed to keep the stock and patterns and one man sharpens and repairs tools and machinery. Aside from them, there are relatively few helpers or unskilled pattern-makers.

The work is all done indoors. It is usually clean and healthy in every way, sharing in these particulars the advantages of the joiner shop.

A large number of men are required in every yard to care for the grounds, clean and repair the buildings, and to store and transport the enormous amount of materials used in construction. While their work is not so spectacular nor quite so interesting as that in some of the other departments, it is nevertheless very necessary and important. There are a few good permanent positions, and many of these tasks offer useful opportunities for becoming acquainted with the shipbuilding business.

While the new yards were being built, a great many carpenters and semi-skilled laborers were needed. Although the number required at present is not so large, every yard requires some men each year for the construction of new buildings and for additions and repairs.

Some conception of what is involved in the upkeep of a large plant may be gathered from these facts concerning Hog Island:

The entire yard covers over 900 acres. About 20 acres are covered with buildings — shops, barracks, mess halls,

storehouses, Y.M.C.A. buildings, and a school for shipbuilders. There are 75 miles of railroad tracks and hundreds of trucks, motor lorries, and traveling cranes are in use. The water supply system has as great a capacity as that of the city of Minneapolis with 350,000 population. The connected electric load is as great as that of the city of Providence, Rhode Island, with 300,000 population. Its air-compressing equipment, with the miles of hose used by riveters, drillers, reamers, and other workmen using air-driven tools, is one of the largest in the world.

The following paragraphs give an account of the work done in the yard maintenance department at the Fore River Plant of the Bethlehem Steel Corporation. At the time these figures were secured, this yard employed approximately 10,000 men.

In addition to the men employed as joiners and ship carpenters, a force of twenty-five to one hundred men is needed for work such as the following: Constructing boxes for and boxing up machinery and patterns; building houses over boilers; repairing and laying tar paper on buildings; building forms for concrete work; inside and outside repair work of all kinds on buildings and fences; making benches, racks and bins for storehouses; boxing pipe lines. House carpenters or concrete form men are familiar with this type of work.

The yard maintains a total of ten miles of standard-gauge track besides a short street railway and a considerable amount of narrow-gauge track running into the shops. There are eighty-seven frogs and switches, ten cross-overs, two trestles, and several bridges to be kept in shape. About twenty men are constantly at work repairing the tracks and keeping the equipment in running order. Section hands, or men experienced in street or

THE INTERIOR OF A MACHINE SHOP
In the foreground are some propeller-blades and a propeller-shaft

road work, are well adapted to fill these places. Foremen or gang leaders should have railroad experience with section gangs. Crane operators, engineers, firemen and switchmen are occasionally needed.

There is a great deal of miscellaneous work requiring unskilled laborers. Pick and shovel men lay pipe lines, clear away for foundations and keel blocks, handle snow, and assist in keeping the railway tracks clear. There are numerous pipe lines for compressed air, steam, water, and gas to be laid and repaired.

This department unloads from the cars and distributes all coal, coke, charcoal, fuel oil, tin, lead, zinc, copper, aluminum, and lumber. It also helps to unload cars for the Receiving Department.

About one hundred acres of the yard and all the ships must be kept clear of rubbish and scrap. A gang of fourteen bolt pickers gathers up the bolts that need to be rethreaded or fixed over in order to be used. Ten teamsters and as many more helpers are needed to haul materials, scrap, and lumber. Twenty men are needed to clear away the rubbish from the docks alone. The ships must be cleaned inside and outside. Steel turnings and odds and ends of steel and lumber are picked up and sorted to sell. Many barrels of bolts, washers, rivets, nuts, and bits of iron are collected and sorted every day.

The employees in the warehouse department at Fore River are classified as follows: 1 chief clerk; 2 stenographers; 2 shippers; 1 pricing clerk; 4 stock clerks; 5 receivers and checkers; 6 warehouse clerks; 2 supervisors of the sale of scrap; 3 truck drivers; 4 spare part men; 25 laborers to handle material.

Freight checkers, stockroom clerks, tool-room clerks, and baggage men are well adapted to the better classes

of this work. It is difficult to secure efficient workmen. The pay varies from seventeen to twenty-five dollars per week. Unskilled workmen are hired to handle material.

Throughout the yard there are power-house boilers connected with the shops, and in the foundry and steel mill there are special furnaces. All of these require constant repair and attention from the masons in the yard maintenance department. It is also the duty of these masons to lay the fire brick for the boilers in all the ships. Occasional repair jobs require the laying of red brick or pressed brick, but nearly all the work deals with fire brick laid in special clay. On the destroyers, every brick is bolted in place and a special fire clay, almost like cement, is used as mortar. Men are needed who understand fire-box and boiler work. It is frequently necessary to do repair work, or to install boiler foundations under very trying conditions. The heat is often intense and the quarters are frequently cramped. On this account, young, active men are desirable. At present, the department is running short-handed because the right men cannot be found.

A number of unskilled workmen are used as helpers. Their work is similar to that done by mason's helpers on outside work.

Steam pipes, hot and cold water pipes, boilers, feed water heaters, and evaporators are covered with magnesia, asbestos, or hair-felt pipe covering. Cement is used for irregular shapes. Canvas is usually sewed on over the covering to protect it from injury.

First-class pipe-coverers are developed from helpers. In six weeks a green man can learn the most important parts of the trade, but it takes from one and one half to two years to become fully proficient on all classes of

work. Plasterers, stucco-workers, cement-workers, and bricklayers are the best material for pipe-coverers outside of journeymen employed on similar work in factories and heating and power plants. The ability to use a trowel is their chief asset.

The production of power, heat, and light requires one or more power stations in each yard. Each of the larger shops has its own heating and power plant. A typical list of workmen for a power house consists of the following: 1 chief engineer; 5 engineers; 5 oilers; 3 water tenders; 6 firemen; 7 coal passers; 1 repair machinist; 2 cleaners; 1 helper; 1 office boy. The work does not differ from that done by similar workmen in any power plant.

One or more parties of civil engineers are always needed to run grade lines for keel blocks, set shaft lines, make out yard maps of progress, and run lines for new buildings. A few transit men, levelers, rodmen, and draftsmen are required for this work.

A considerable number of marine engineers are required to install and test the engines on board the ships. They are generally classed as outside machinists, but it is essential that they be accustomed to the repair and operation of the standard types of marine engines in addition to being experienced assembling machinists.

Fore River, in common with many of the yards, has several tugboats which must be provided with full crews, including engineers.

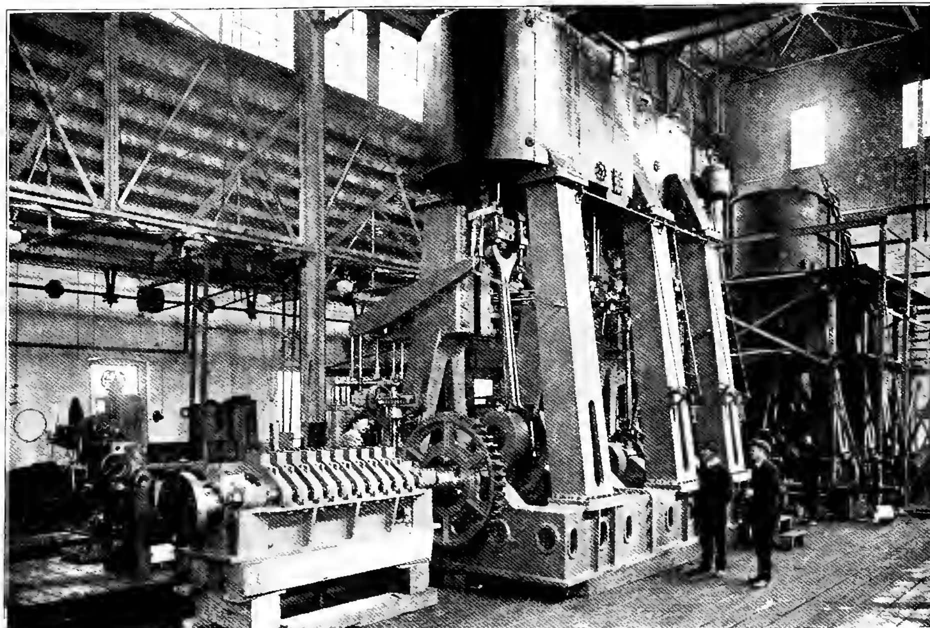
Two pile drivers are in constant operation, one for land work, the other one a floating pile driver. This work includes building docks and driving piles for the launching ways. An engineer and several dock builders are required for each gang. Men who have had experience as bridge carpenters, or on dock or trestle work, or any kind

of heavy, rough wooden structures are desirable as employees. The work is entirely different from that of house carpenters, and men with experience of this sort are not, as a rule, encouraged to undertake it.

Yard construction and repairs call for a few men who are familiar with work in cement and reinforced concrete. Several men are constantly employed on foundations for machinery, concrete floors, sidewalks, steps, etc. A few carpenters are needed to build forms. This class of work presents no peculiar or unusual difficulties to men who have done similar work outside of the yards.

In most yards, the salvage department offers numerous opportunities for unskilled laborers as well as for boys, older men, and those who are physically handicapped. After less than a month of actual operation, the salvage department of the Pusey & Jones Shipyard, Gloucester, New Jersey, showed net receipts for a week of more than $5800. Everything from a discarded drinking-cup to a broken-down engine is utilized by this department. Not only does it justify itself by turning discarded odds and ends into capital, but it also has proved to be a most effective agent for keeping the yards of the plant free from rubbish.

Whenever a superintendent sends a request to have a section cleaned up, a gang is sent to gather all the refuse and take it to the salvage yard, where it is properly separated. What is junk in the shipyard is wealth to the salvage department. All the waste paper which is picked up around the plant is baled and sold; the staves are knocked out of old rivet barrels to be sold for kindling, while the bands are sold for scrap iron; the ends of broken electric light bulbs are valuable because of the copper in them; and the large spools or drums around



A MARINE ENGINE BUILT IN A SHIPYARD MACHINE SHOP

Each engine is assembled and tested before being installed on the ship. Erecting machinists and men for outside work on the ships are greatly needed in many of the yards. Director-General Charles M. Schwab has been emphasizing the need for an enlarged programme for building engines and auxiliary machinery

which wires are wrapped are turned back to the manufacturers for rebates. The revenue from the sale of baled paper more than meets the cost of the labor of collection, and thus the yards can be kept clean without any real expense to the company.

All the old bolts, burnt rivets, lathe turnings, odd pieces of scrap iron and steel, and odd pieces of lumber are taken to the salvage yard, where they are carefully sorted out and placed in bins or piles.

Many bolts are rethreaded, and nuts retapped, and sent back to the stock departments. Pieces of lumber which are too short for one purpose are often suitable for others, and can be sent back to be used in other parts of the yard. Pieces of lumber which cannot be used for any purpose whatsoever are sold for kindling wood. This wood is sold to any and all comers and brings from $1 to $2.50 a load, according to the size. Refuse which can in no way be used again or turned into money is burned in an incinerator.

CHAPTER IX

EXECUTIVE AND CLERICAL POSITIONS IN SHIPBUILDING

OUR chief lack in this yard to-day is not larger shops, or a more plentiful supply of steel, or skilled mechanics. We have one of the best shipbuilding plants in the country, the rolling mills are sending us more steel than we can use, our training school is highly successful in turning out good workmen, yet every department head in the yard knows that our output ought to be much greater than it is. We come nowhere near getting out of our working force the production of which it is capable. This situation can all be charged to one cause — our inability to find the right kind of foremen. We want men who understand how to plan their day's work, how to organize their men, and how to divide the jobs to the best advantage among the different gangs. We must have men who can instruct others and lead them, men who can gain the confidence and the coöperation of those who work with them.

"As Head of the Production Department, I am directly responsible for the erection of the hulls on the twenty-eight shipways and for the installation of the machinery and the finishing of the vessels at the outfitting piers. Under me are three assistants, one in charge of each fourteen ways, and a third who is superintendent of the wet basin or outfitting piers. Under these men are fourteen foremen who have charge of two hulls each, thus making it possible for them to shift groups of men from

one hull to another as the requirements of the work make it necessary. There are also foremen in charge of each of the different trades, such as riveting, chipping and calking, and erecting. Our 'pushers,' or gang leaders, are responsible for still smaller groups of mechanics. My hardest task is to find suitable men for these jobs where leadership is required. A few can be found among bridge-builders and structural steel workers who can do our work very well, but they seldom know how to handle men properly. The only way out appears to be to provide special training classes for foremen."

This statement from an executive in one of the leading yards building fabricated ships is fairly representative of the shipbuilding industry and, in fact, of all large enterprises. The new spirit in management which demands better supervision and training of employees and which endeavors to enlist their interest and coöperation in the conduct of the work, calls for a new type of foremanship. Men who can discharge these duties acceptably need have no fear of ready promotion in the shipyards.

Plans have now been adopted by the Emergency Fleet Corporation for special training courses for foremen similar to those which are being conducted for instructors to teach the shipyard trades and for employment managers. The methods used will be somewhat similar to those already in use for other forms of training carried on by the Education and Training Section of the Industrial Relations Group.

Mr. Meyer Bloomfield, formerly head of the Industrial Service Section of the United States Shipping Board Emergency Fleet Corporation, writes on this subject:

Any plant organization is as strong only as its weakest foreman link. A new profession is developing, among other new

professions, in this age of science, that of foremanship. Employment, the general handling of men in production, all these familiar activities have been subjected to scientific and educational scrutiny with the result that new vocational specializations with a program of training for each are in process.

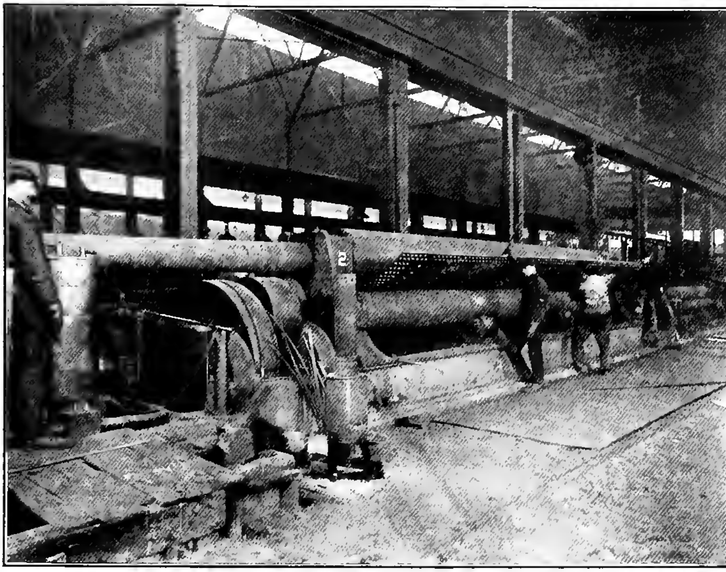
The work of the foreman is undergoing the same changes. What is sought is a standardization of good practice, organization of the best experience among successful foremen, in order that all foremen may benefit by the lesson.

Foremen have it in their power not only to affect output; what they say or do or omit to do influences the whole morale and spirit of the working force. As the direct agents of production departments, they are, of course, responsible for a given result. Their skill and technical knowledge are prime factors in securing such result. But the foreman works not only with things, but also with men; and working with men or with human nature is a far more complicated business than working with material.

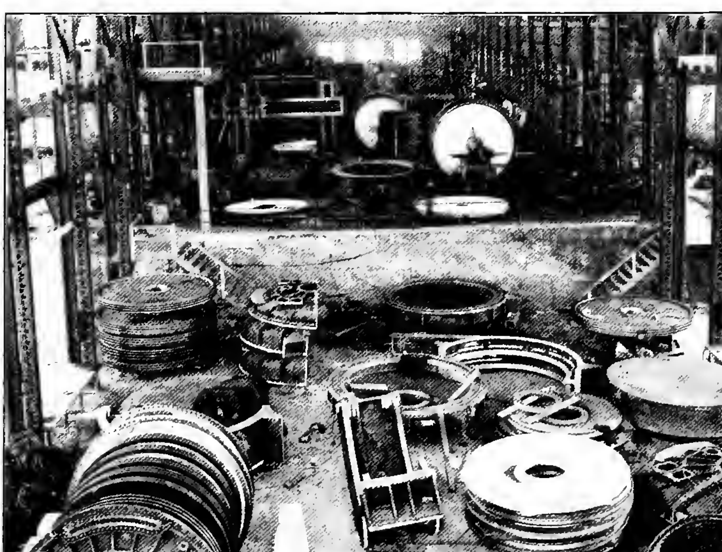
The idea of the new foremanship is based on the purpose to equip the foreman with the information, the viewpoint, and the attitude toward his daily man-power problems which will enable him to act fairly and intelligently. Some foremen do so act, of course, because they are fair and intelligent by nature. Their interests are broad and they possess the knack of winning the confidence and coöperation of the men whom they supervise. Other foremen may possess first-class technical equipment but seem to be poor hands in getting along with men. Finally, a large class of foremen wish to do the right thing, but are handicapped by their lack of information as to how given situations can best be handled, or how similar problems have been mastered elsewhere.

This condition therefore points to the advisability of subjecting the work and position of the foreman to analysis. We must define the various powers and duties of the foreman in terms of his relationship with the plant as a whole, with the men he is responsible for, and with the various activities of the plant, such, for example, as the service or employment department.

Obviously the foreman has a distinct relation to each of these



ROLLS FOR SHAPING PLATES AFTER PUNCHING AND SHEARING



THE ERECTING PIT FOR TURBINES IN A MACHINE SHOP

Galleries are provided on either side of this shop for brass and copper work, tool rooms, and a variety of small work on lathes and milling-machines

divisions, and it is of practical importance that he have a clear picture in his mind of just what his place is in relation to them.

The foreman stands between the management and the men. In a sense, he is their common interpreter. Nobody works closer to the men than he does. If he is open-minded and interested he is constantly learning of conditions which affect the state of mind of the workers and their efficiency.

In his own sphere he is usually supreme, and the way he uses his power over men can accomplish more than any other one factor to make them satisfied or discontented, and production is very largely influenced by the good-will or ill-will of the men. It is clear that in addition to industrial fitness, a foreman must know something of the thoughts, ambitions, aspirations, and ideals of the mass of the workers under him. He must know and understand. More than this, he must sympathize. The fact is, he will sympathize if he understands.

The foreman rules either through force or through understanding. The best plants have learned that far better results come through working with men than through driving them. Many plants have started foremen meetings, conferences, and organizations in order to develop good practice. Such meetings are immensely valuable and will some day be a feature of every modern industrial organization. Shipyards have been leading in the matter of foremen organization with results wholly beneficial to the work and to the men.

There is need in the shipbuilding industry for a considerable number of employees with more training than is usually offered in a trade school, but less than that required of marine engineers or naval architects. They should have a better grasp of science, mathematics, and mechanical drawing and more knowledge of the principles of organization and management than the classical high-school course or the trade school usually develops. Among those who need training of this kind are foremen, assistant foremen, leading men or gang leaders, estimators, rate-setters, stationary engineers, time-

study men, cost and efficiency engineers, special draftsmen and clerks in shop offices, and men engaged on highly skilled work requiring either long experience, or technical training and a short period of apprenticeship.

Tables 1 and 2 will serve to show something of the possible demand for persons having technical preparation of this kind. An examination of the figures for the different yards in Table 1 shows a wide variation in practice as to the relative number of men in the several departments. This condition is due in part to differences in the kind of work being done, but the principal reason lies in the inability of the yards to secure enough skilled mechanics for certain departments. Thus yard No. 1 has a very large number of erectors and bolters-up, many of whom are merely under training in that division with the intention of transferring them to other work.

In Table 2, the divisions and figures in heavy black type indicate the departments where more adequate training is likely to bring advancement. On the whole, these figures are probably considerably in excess of the number of persons now in the yards who have been adequately trained, but they are a conservative estimate of the number who need special instruction.

The subordinate managerial and executive positions, as well as the more desirable places calling for technical knowledge or special skill, have been reached in the past in the following ways:

1. By chance promotion after long service in firms where little or no attention is given to selecting men or to mapping out the lines of promotion.
2. By personal study and analysis of the tasks ahead of them on the part of persons who were determined to succeed.

TABLE 1. NUMBERS AND PER CENT OF EMPLOYEES IN THE LEADING MECHANICAL TRADES OF FIVE TYPICAL STEEL SHIPYARDS

Department	Yard No. 1		Yard No. 2		Yard No. 3		Yard No. 4		Yard No. 5		Totals	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Anglesmiths	23	0.5	37	0.7	27	0.9	25	0.5	34	0.8	146	0.7
Blacksmith shop	103	2.2	54	1.0	63	2.2	40	0.8	64	1.5	324	1.5
Boiler shop	135	2.8	70	1.3	116	4.1	128	2.4	65	1.5	514	2.3
Calkers and chippers	217	4.5	196	3.7	91	3.2	255	4.8	122	2.8	881	4.0
Copper shop	18	0.4	39	0.7	61	2.2	80	1.5	65	1.5	263	1.2
Drillers and reamers	264	5.5	441	8.4	550	19.7	450	8.5	375	8.8	2,080	9.3
Electrical shop	154	3.2	142	2.7	41	1.4	125	2.4	94	2.2	556	2.5
Erectors and bolters-up	615	12.7	400	7.6	350	12.5	430	8.1	365	8.5	2,160	9.6
Fitters	149	3.1	215	4.1	128	4.6	210	4.0	212	4.9	914	4.1
Foundry	130	2.7	60	1.1	55	2.0	126	2.4	69	1.6	440	2.0
Galvanizing	8	0.2	10	0.2	8	0.3	7	0.1	9	0.2	42	0.2
Joiner shop	105	2.2	32	0.6	47	1.7	157	3.0	89	2.1	430	1.9
Machine shop	479	10.0	983	18.8	176	6.3	563	10.7	682	16.0	2,883	12.9
Mold Loft	88	1.8	46	0.9	24	0.8	45	0.8	50	1.1	253	1.1
Naval architecture	95	2.0	86	1.6	45	1.6	46	0.8	119	2.8	391	1.8
Outside machinists	141	2.9	250	4.8	33	1.2	264	5.0	144	3.4	832	3.7
Oxy-acetylene	20	0.4	15	0.3	19	0.7	12	0.2	17	0.4	83	0.4
Paint shop	179	3.7	124	2.3	45	1.6	198	3.7	89	2.0	635	2.8
Pattern shop	51	1.0	62	1.2	20	0.7	42	0.8	48	1.1	223	1.0
Pipe shop and plumbing	321	6.7	206	3.9	47	1.7	256	4.8	255	6.0	1,085	4.9
Riggers	115	2.4	121	2.3	20	0.7	296	5.6	80	1.8	632	2.8
Riveters	551	11.5	564	10.7	324	11.6	490	9.3	325	7.6	2,254	10.0
Sheet-metal shop	82	1.7	170	3.2	38	1.3	60	1.1	97	2.2	447	2.0
Shipwrights	194	4.0	277	5.3	50	1.8	298	5.6	103	2.4	922	4.1
Steel mill	292	6.4	300	5.7	203	7.3	424	8.0	573	13.4	1,792	8.0
Yard and ship laborers	280	6.1	330	6.3	205	7.3	253	4.8	125	3.0	1,193	5.4
Total number of workers in these departments in the yard	4,809		5,230		2,786		5,280		4,270		22,375	

TABLE 2. THE PERCENTAGE OF MINOR EXECUTIVES AND OTHER PERSONS NEEDING TECHNICAL TRAINING IN THE LEADING TRADES IN THE SHIPBUILDING INDUSTRY

(Based on totals for two yards building steel ships)

Department	*Total number employed in these departments*	*Number of persons needing technical training*	*Approximate per cent needing technical training*
Anglesmiths, blacksmiths, drop forging, and die-sinking	356	20	6
Boiler shop	255	25	10
Copper shop	100	13	13
Electrical shop	279	147	53
Erecting trades[1]	3,161	128	4
Fitters	492	162	33
Foundry	252	50	20
Joiner shop	263	26	10
Machine shop	1,163	166	15
Mold loft	123	39	32
Naval architecture (all drafting work)	240	200[3]	83
Outside machinists	405	91	23
Paint shop	379	20	5
Pattern shop	93	57	61
Pipe shop and plumbing[2]	575	105	18
Sheet-metal shop	177	49	28
Ship carpenters	473	36	8
Steel mill	716	43	6
Yard riggers and laborers	1,049	41	4
Total	10,551	1,418	13

Estimated number of office employees, and members of staff organization requiring technical or commercial training.... 300
Estimated number in Government Inspection Department needing technical or commercial education................ 200

[1] Includes chipping, calking bolting, drilling, reaming, riveting, erecting, and testing.
[2] Includes machinists who install turrets, ordnance handling machinery, etc.
[3] No exact data available. Probably nearly all of these persons should have technical training.

3. By starting at the bottom and preparing for advancement by attending evening classes or taking correspondence courses.
4. By the transfer to these posts of men who served a

short term of apprenticeship after a thorough technical preparation in universities or technical institutions.

5. By the selection of graduates of trade schools or of high-school manual training courses who knew how to read blue-prints and had some elementary acquaintance with woodworking or machine-shop tools.
6. By the promotion of graduates of the commercial courses of high schools or business colleges or of college schools of business administration.

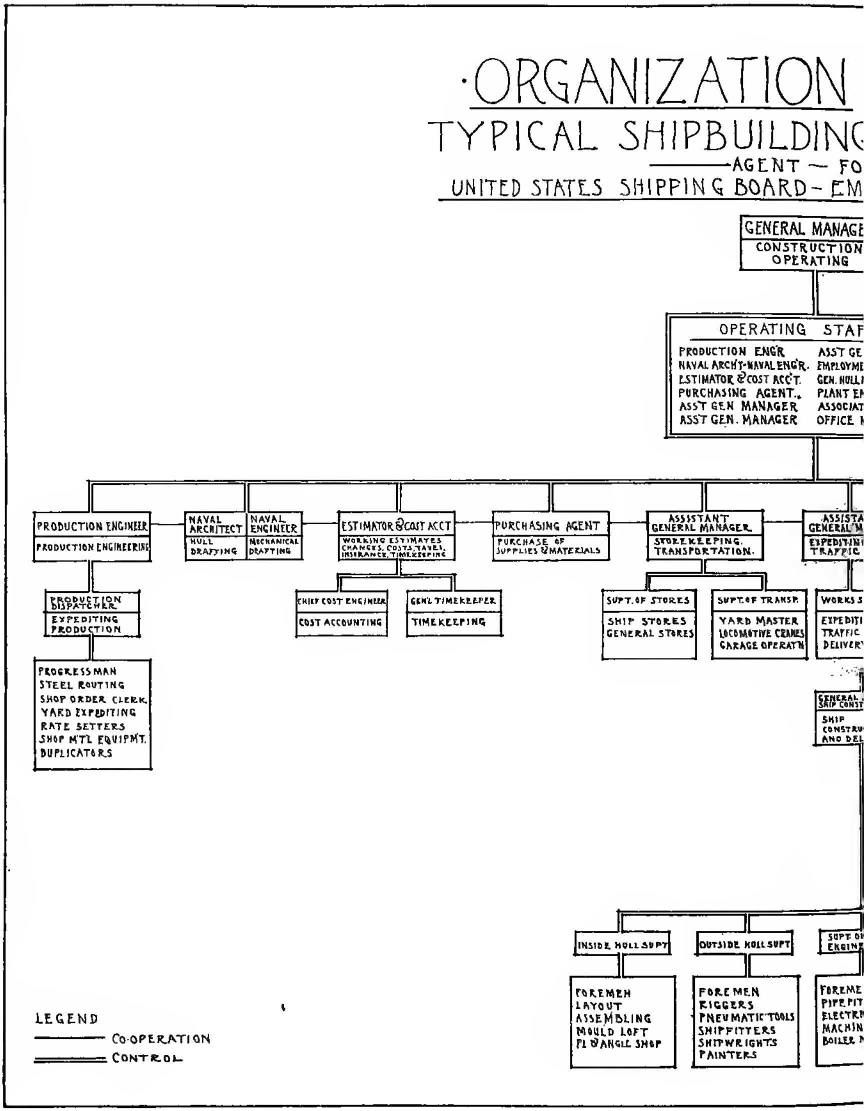
The kind of training which young men should have who expect to prepare themselves for positions of responsibility in shipbuilding depends very largely upon the department which they wish to enter. There is no longer any such thing as "learning the shipbuilding business." One must qualify for some particular kind of work and bend his energies toward becoming proficient in that line. College training may fit a man for some one of the offices, such as cost accounting or the purchasing department, or he may enter the machine shops or hull or engineering drafting, according to the kind of courses he has pursued. Those who have had trade or technical preparation may enter some one of the woodworking or metal shops or any of the hull construction trades such as ship-fitting, mold-loft work, or erecting. Advancement will depend upon the ability to develop the necessary qualities of judgment, skill, and leadership.

During the war period, special classes will continue to provide training for beginners in the shipyard trades. This preparation is being confined to highly specialized tasks, and those who desire to gain a broader knowledge of their work, such as will qualify them to hold more re-

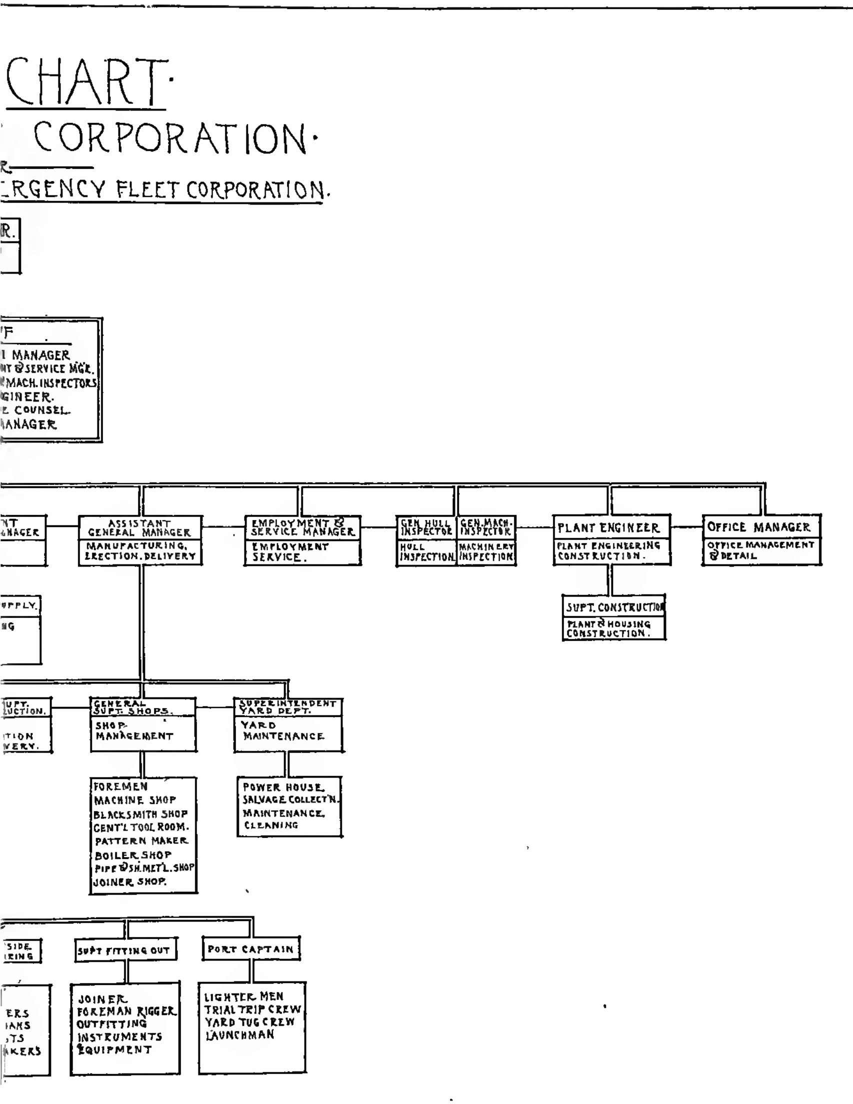
sponsible positions, must expect to supplement this emergency training in other ways. For the technical school or college graduate, it will probably be all of the instruction necessary for a good beginning; the alert man will be able to acquire the other needed information as he goes along.

The organization chart shows the lines of authority from the general manager down through the various departments, as well as the nature of the work done in each division. Each department, and many of the larger shops, requires a corps of office assistants in addition to a small group of executives. The sections which follow describe the organization of the more important offices and the opportunities for employment in them.

The two divisions of the work of the shipyard which offer the most attractive opportunities for advancement to executive positions have already been considered in some detail in previous chapters. These divisions are production, both in hull construction and in the work of the shops, and naval architecture on either the hull or engineering side. In the earlier days when small yards and separate specifications and designs for each vessel were the rule, these were practically the only avenues by which aggressive, capable men could hope to gain promotion. The leading shipbuilders came up through apprenticeship in the yard trades and were quite familiar with many different branches of the industry. With the development of the standardized ship and the building-up of organizations employing thousands of persons, all this has been changed. A much larger office force is required and more highly trained and better paid executives must be placed in charge of the different administrative divisions. Many of the office departments now call for a considerable number of high-



·ORGANIZATION
TYPICAL SHIPBUILDING
AGENT — FO
UNITED STATES SHIPPING BOARD — EM
GENERAL MANAGE
CONSTRUCTION
OPERATING
OPERATING STAF
PRODUCTION ENGR.
NAVAL ARCH'T-NAVAL ENGR.
ESTIMATOR & COST ACC'T.
PURCHASING AGENT.
ASS'T GEN MANAGER
ASS'T GEN. MANAGER
ASS'T GE
EMPLOYME
GEN. HULL
PLANT EN
ASSOCIAT
OFFICE
PRODUCTION ENGINEER
PRODUCTION ENGINEERING
NAVAL ARCHITECT
HULL DRAFTING
NAVAL ENGINEER
MECHANICAL DRAFTING
ESTIMATOR & COST ACCT
WORKING ESTIMATES CHANGES, COSTS, TAXES, INSURANCE, TIMEKEEPING
PURCHASING AGENT
PURCHASE OF SUPPLIES & MATERIALS
ASSISTANT GENERAL MANAGER
STOREKEEPING. TRANSPORTATION.
ASSISTA GENERAL M
EXPEDITIN TRAFFIC
PRODUCTION DISPATCHER
EXPEDITING PRODUCTION
CHIEF COST ENGINEER
COST ACCOUNTING
GEN'L TIMEKEEPER
TIMEKEEPING
SUPT. OF STORES
SHIP STORES
GENERAL STORES
SUPT. OF TRANSP.
YARD MASTER
LOCOMOTIVE CRANES
GARAGE OPERAT'N
WORKS S
EXPEDITI
TRAFFIC
DELIVERY
PROGRESS MAN
STEEL ROUTING
SHOP ORDER CLERK
YARD EXPEDITING
RATE SETTERS
SHOP M'TL EQUIPM'T.
DUPLICATORS
GENERAL SHIP CONST
SHIP CONSTRU AND DEL
INSIDE HULL SUPT
FOREMEN
LAYOUT
ASSEMBLING
MOULD LOFT
PL & ANGLE SHOP
OUTSIDE HULL SUPT
FOREMEN
RIGGERS
PNEUMATIC TOOLS
SHIPFITTERS
SHIPWRIGHTS
PAINTERS
SUPT. OF ENGINE
FOREME
PIPEFIT
ELECTRI
MACHIN
BOILER
LEGEND
CO-OPERATION
CONTROL


CHART·
CORPORATION·
RGENCY FLEET CORPORATION.
R.
F
MANAGER
NT & SERVICE MGR.
MACH. INSPECTORS
GINEER.
E COUNSEL.
ANAGER
NT
NAGER
ASSISTANT GENERAL MANAGER
MANUFACTURING, ERECTION, DELIVERY
EMPLOYMENT & SERVICE MANAGER
EMPLOYMENT SERVICE.
GEN. HULL INSPECTOR
HULL INSPECTION
GEN. MACH. INSPECTOR
MACHINERY INSPECTION
PLANT ENGINEER
PLANT ENGINEERING CONSTRUCTION.
OFFICE MANAGER
OFFICE MANAGEMENT & DETAIL
SUPT. CONSTRUCTION
PLANT & HOUSING CONSTRUCTION.
PPLY.
NG
UPT.
UCTION.
TION
VERY.
GENERAL SUPT. SHOPS.
SHOP MANAGEMENT
SUPERINTENDENT YARD DEPT.
YARD MAINTENANCE
FOREMEN
MACHINE SHOP
BLACKSMITH SHOP
CENT'L TOOL ROOM.
PATTERN MAKER
BOILER SHOP
PIPE & SH. MET'L. SHOP
JOINER SHOP.
POWER HOUSE.
SALVAGE COLLECT'N.
MAINTENANCE.
CLEANING
SIDE
RING
SUPT FITTING OUT
PORT CAPTAIN
ERS
IANS
TS
KERS
JOINER
FOREMAN RIGGER
OUTFITTING
INSTRUMENTS
EQUIPMENT
LIGHTER MEN
TRIAL TRIP CREW
YARD TUG CREW
LAUNCHMAN

grade accountants, as well as technical experts and specialists in various fields. The fact ought not to be overlooked, of course, that many of the office tasks are of a purely routine nature, work which can readily be performed by clerks or stenographers who have had good high-school or business-college preparation in commercial subjects.

The outline which follows gives the leading administrative departments and their subdivisions as they appear in the organization at Hog Island. Although the departments are not so large nor the divisions so numerous in the smaller shipyards, the same general features always appear.

1. Accounting:
   Includes the auditing and payment of bills, records of the cost of production in materials and labor, and general financial statistics. A complete report of the cost of each ship, itemized according to a standard list, is rendered to the Shipping Board.
2. Time-keeping and pay-roll:
   These offices keep a record of the persons in the employ of the company, and make a daily report of the time and earnings of each. These departments, together with accounting, come directly under the supervision of the auditor of disbursements and the treasurer.
3. Designing and drafting:
   The preparation of plans and specifications for steel from the fabricating mills and for machinery and fittings for the shops, as well as plans for additions or new buildings in the yard.
4. Purchasing:
   Specifications for material; orders to the sources oi supply for all materials; inspection of goods delivered; expediting the delivery of orders.
5. Transportation and storage of materials:
   In charge of the transportation of employees and ma-

terials, storage warehouses, and supply rooms. With 28,000 persons on the pay-roll and over 3000 tons of steel to be delivered for each ship, in addition to vast quantities of other materials used daily on the ways, in the shops, and in the office buildings and commissary, many serious problems arise in this connection.

6. Production:

   Directing the productive work of the shops, erecting the ships on the ways, outfitting and finishing the vessels in the wet basin; the control and distribution of materials; preparation of the construction schedule for the work on the ways and in the shops.

7. Industrial relations:

   Consists of the following divisions: Employment, medical, service or welfare, housing, employment and welfare for women, accidents and workmen's compensation, information, statistics. (For a complete discussion of the work of similar departments see Chapter XI.)

8. Commissary:

   Hotel and cafeterias.

9. Protection:

   Secret service, guards, traffic policemen, fire department.

10. Training school:

    A training center for instructors and a school for training employees in the shipyard trades. (See Chapter XI.)

11. Telephone exchange and office managers:

    There is a large central telephone exchange connecting all departments. The stenographic and clerical force is centralized under one head and each office building has an office manager in charge of all clerical work.

More technical men and fewer bookkeepers and clerks are needed in the production department than in the other main offices. After the schedule has been made for the several parts of the work to be done on each ship, requisitions must be sent to the transportation and

storage departments for the delivery of steel and other materials in the quantity needed on the dates specified. In so large an organization it is an exceedingly complicated problem to keep all of the machines and men supplied with material and to regulate the work of the shops to meet the daily demands of hull construction. Serious losses are sure to occur if tools are not at hand when they are wanted, or if the stream of material gets delayed at any point. The Submarine Boat Corporation, for example, has found it profitable to employ in this connection a corps of six to eight efficiency men. It has been their duty to work out the sequence which should be followed in erecting, riveting, chipping and calking, painting, and other operations so that the work could be done to the best advantage and with the least waste of time and effort.

In addition to the superintendents, foremen, and gang leaders in direct charge of the work, an office staff is required consisting almost entirely of clerks and stenographers. One of the yards employing about 14,000 persons has a total of 350 men and women in this department, only five of whom are expert stenographers. The majority have had only a small amount of clerical training or experience. A few of the larger shop offices usually have two or three clerical assistants.

In the hull department, men and boys called "counters" are employed to keep account of the amount of work done by riveting gangs, chippers, calkers, bolters, reamers, and other piece-workers. The work is largely of a routine nature, and while some clerical training is helpful, it is not insisted upon as a rule. The most difficult part of the task is to learn the parts of the ship and the different classes of work so as to be able to select

the right rate from the price list. The blanks to be filled out are not complicated, but a great many are needed every day.

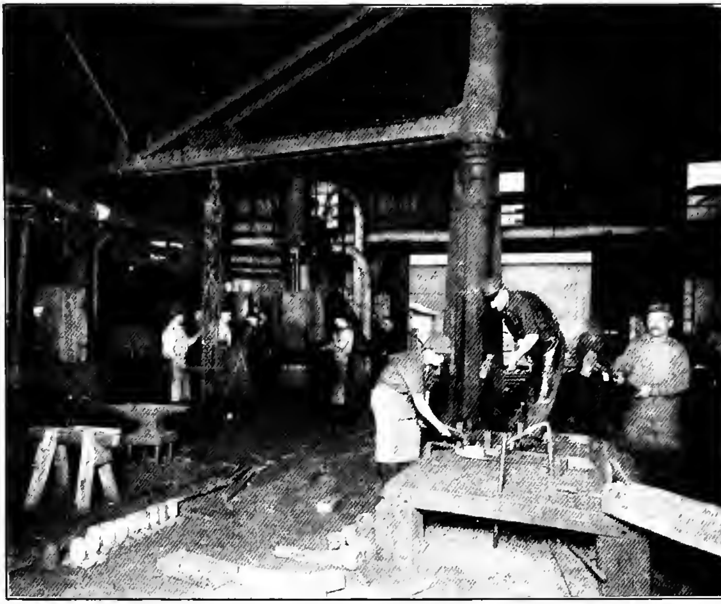
It is easy for a counter who is not tactful or courteous to cause dissatisfaction, and his carelessness may easily result in considerable loss to the company. The counter must write a legible hand and must be accurate in the simple processes of arithmetic. He should have a high-school education, but this is not absolutely necessary. Strong, active persons are required since there is a great deal of climbing and walking to do.

A continuous record is kept in each shop of the price paid for all tasks and of the time required to complete them. From these records, and from his knowledge of conditions, the rate-setter places a valuation upon any given piece of work.

Nearly all rate-setters have had some shop experience. This does not need to be on actual machine work. A man may become accustomed to the work of the shop as a clerk or time-keeper, or by actually serving time as a mechanic.

The shop clerk punches each man's card when he begins and when he stops work on each task, and assists the rate-setter and foreman in various ways. Only ordinary clerical experience is required.

In addition to the opportunities described in the following section on the accounting department, the main offices of every shipyard employ a number of bookkeepers, clerks, stenographers, and messengers. The time-keeping, purchasing, and employment and service departments are examples of offices requiring a considerable number of such persons. It has been customary to employ men for most of these positions, but there is no


ANGLESMITHS AND DROP-FORGING IN A BLACKSMITH SHOP


FORMING COMBUSTION-CHAMBER PLATES ON A HYDRAULIC FLANGING MACHINE

Water-pressure operates the piston, on the end of which is a die for shaping the steel plate

reason why a large amount of the work cannot be done by capable women.

Graduates of the commercial department of a good high school are fully qualified for the majority of these positions. A few persons having more extended experience are occasionally needed. Promotion is usually very slow and there are few chances for self-improvement.

The organization of a typical time-keeping office is given as an illustration of this kind of work.

EMPLOYEES IN A TIME-KEEPING OFFICE

Time-keepers (outside)	10 men
Pay-roll clerks	20 men and boys
Index clerk	1 man
Deduction clerks	3 men
Force report	1 man
Stenographer	1 girl
Printing shop	2 men and 1 boy
Addressograph	1 man and 2 boys
Annual wage report	4 girls

The principal machines in use with which a prospective employee should be familiar are adding machines and the comptometer. Familiarity with machines is not so essential as accuracy in the use of figures and the ability to do neat, exact work.

Among the best opportunities for accountants, clerks, statisticians, and other similar office employees are those to be found under the supervision of the plant accountant. This division does not appear in the organization chart on page 208 because it is usually in charge of the comptroller or treasurer of the company. A very complete department of this kind has been established by the Merchant Shipbuilding Corporation at Bristol. The outline given below follows the plan of that company in its

main points, but it may be considered as fairly representative of what will be required in any large plant.

The work of this department is divided among twelve bureaus or divisions, all under the control of the plant accountant. Under him are two or three assistants who direct the office routine. The employment opportunities as well as the nature of the duties performed are considered separately under each of these divisions in the sections which follow:

1. *Statistics.* In coöperation with the cost engineer, statistics and financial statements are prepared for the Emergency Fleet Corporation. Only a few highly trained financial experts, familiar with shipyard practice, are required.

2. *General bookkeeping.* A record is maintained of all bills paid, accounts due, and of open accounts with the work in progress. Frequent cost analyses of different kinds are asked for to be used by the general manager, the production department, and other divisions of the yard. At least six experienced bookkeepers are required who are able to diagnose a document quickly and tell where the cost should be placed. It is hard to find men who can do such work well who are also familiar with shipbuilding practice.

3. *Claim bureau and the record of shipments of steel.* (*a*) Adjustments must be made with carriers and dealers for freight. Bills are presented by outside firms F.O.B. Bristol which give rise to disagreements as to freight classifications. Shortages and other claims for damages in transportation come under this department.

(*b*) Records are kept of the contracts with the rolling mills and with the fabricating shops. The accounts must show, for example, how many tons of steel are shipped

by Carnegie Steel to the American Bridge Company for fabrication and how many tons finally reach the yard. Cutting and punching out rivet holes cause a loss of about six and one half per cent by weight during the fabrication process.

(*c*) Claims for mistakes in ordering material, for errors in shipment, or for blunders in fabrication must be adjusted. At least one man is needed who is familiar with the Interstate Commerce laws and with the procedure in securing the affidavits upon which claims can be established. Men experienced on similar commercial work, of high-school training or better, are sought for this division.

4. *Material accounting.* The division of material accounting establishes the receipt of all material and has charge of invoices and the pricing of requisitions. About fifty persons are employed, the majority of whom are bookkeepers, stenographers, and filing clerks. At least half of these are women. Except for a few positions requiring expert knowledge and familiarity with shipbuilding, only commercial or clerical training of high-school grade is necessary. Public school teachers, especially from commercial departments, are sometimes employed during vacation periods.

5. *Pay-roll.* The pay-rolls from each department are checked as to rates, extensions, and deductions. The limit set by the Macy Wage Board must not be exceeded nor can arbitrary changes in rates appear. Deductions from wages are made for the Liberty Loan and for such items as house rent, fuel, and light, which are supplied to employees by the company. At least two men are needed who are experienced on pay-roll work. The remainder of the force consists of two or three men of ordi-

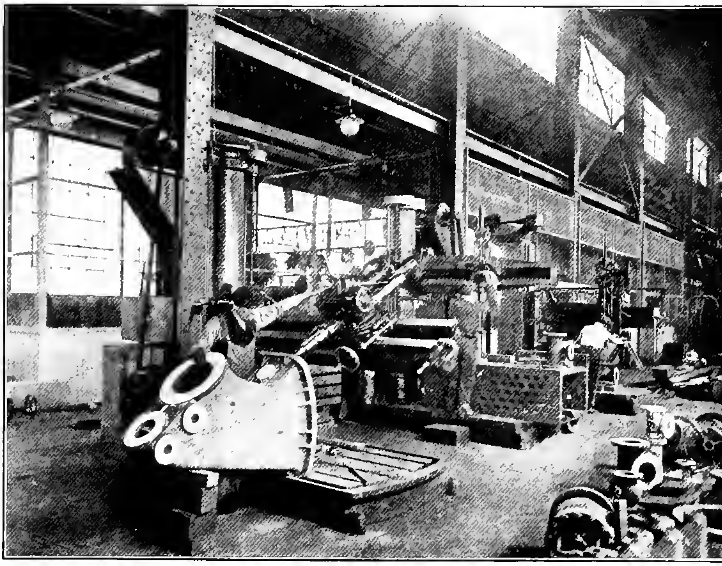
nary clerical experience and four or five girls who have had the equivalent of high-school training.

6. *Comptometers.* These machines are used on every possible piece of work done in the department. This division assists each of the other sections of the office. Seven or eight young women are employed who are competent to operate the Burroughs or other makes of adding machines.

7. *Stenographers.* The stenographic division is similar to the one mentioned above. From fifteen to twenty stenographers are employed who assist in the work of the other divisions. They write out bills for all material, vouchers, and receipts, and carry on the necessary correspondence for the department.

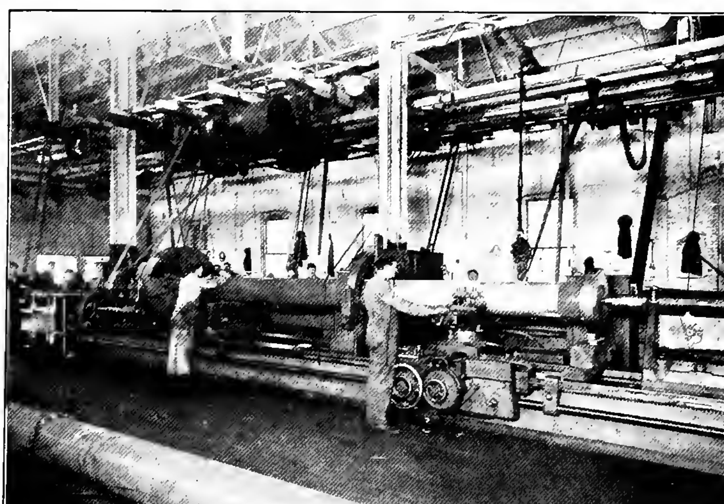
8. *Bills payable.* A large company will handle from five hundred to six hundred bills for material each day. These must be audited and placed under the proper heading in the detailed record of costs. The department requires about thirty people, at least twenty of whom may be girls or women. The man in charge needs general accounting experience such as would be afforded by railroad offices. In many respects the whole work of the accounting department resembles that of the auditor of disbursements in a railroad system, and on that account men who have had railroad experience are quite likely to be successful in the more important accounting positions in shipbuilding.

9. *Price checking.* All vendors' bills must agree with the price shown on the purchase orders. Overshipments, substitution for the materials requisitioned, and errors in shipment must be guarded against. Numerous parts of the work are under the supervision of the Emergency Fleet Corporation. From eight to ten persons are em-



DRILLING A HEAVY CASTING

Much of the work in the machine shops is on very large castings. It is difficult to find men who can handle work of this kind



MILLING A PROPELLER-SHAFT ON A 60-FOOT LATHE

The cutting tool is in front of the man in the center

ployed, the majority of whom need only ordinary clerical training and experience.

10. *Filing.* Five or six girls are employed in filing the records of the different divisions of the department.

11. *Time-keeping.* The cost of the work done by each man must be distributed to the account of the jobs in which he may be engaged. It is necessary for those who do this work to be familiar with the piece-rate schedules. They check the time lists, transcribe figures, and use the comptometer.

12. *Accounting specialists.* A number of high-class men are employed who are responsible for various details in connection with invoices, freight charges, agreements with contractors, and discounts. Emergency cases occur in which the accounts can only be cleared up by some one who is familiar with local conditions, who can examine into the original orders and follow them through the office routine. The specialist on freight analyzes the accounts with carriers to see that payments are made promptly and to follow up important claims for failures in shipping. Inventories must be made and local conditions studied in connection with material and production accounting. Very few of these men have had shipyard experience. Men from similar commercial lines, or those who have had railroad experience, can be readily adapted to the work of this division.

The wages and salaries of clerks and other employees are usually about as follows in the accounting department:

Heads of divisions		$175 per month
Special accountants	$160 to	170 per month
Clerks (women)	70 to	85 per month
Stenographers	80 to	105 per month
Clerks and bookkeepers	110 to	135 per month
Price clerks and ledger clerks	135 to	150 per month

CHAPTER X

THE BUILDING OF WOODEN SHIPS

THE building of wooden ships has received such an impetus during the European War that it deserves special treatment, both because of its magnitude and because of the opportunities it offers for employment. It was the first form of boatbuilding and shipbuilding. It was employed by all of the maritime races from the dawn of history down to a generation ago, when iron and steel came into general use. The history of American shipyards from Maine to Florida, from Florida to California, from California to Washington, and on the Great Lakes, is practically that of wooden ship construction. Our great forests of pine and oak, in the Northeast, in the South, and on the Pacific Coast, are unrivaled the world over. And American shipbuilders and shipworkers are still unexcelled, as they were in the days of the thirty-ton pinnace, the "clipper ship," the squadron of Commodore Perry, and "Old Ironsides," which is still floating at the Charlestown Navy Yard.

The Emergency Fleet Corporation is building wooden ships because it is the logical thing to do. Steel ships could not be produced fast enough to meet all of the demand. Wooden ones can be built at the same time to excellent advantage. We have the forests, we have the yards, both old and new, we have the workmen, and we have the capital to launch wooden bottoms on all our coasts and rivers. This is now being done.

The natural divisions of wooden ship construction,

from the offices to yard work, are shown in the following parallel lists:

General departments in a wooden shipbuilding plant	*Corresponding divisions of workers in a wooden shipbuilding plant*
1. General offices............	Manager, assistants, purchasing agent, paymaster, stenographers, and clerks.
2. Drafting room............	Draftsman, assistants.
3. Mold loft	Draftsman, boss carpenter, template maker.
4. The yard	Men accustomed to handling lumber, laborers, yard-riggers, hewers, bevelers, boss carpenter, carpenters, teamsters.
5. The hull	Boss carpenter, ship carpenters, liners, bevelers, plank-workers, fasteners, dubbers and squarers, calkers, blacksmith, ship-riggers, joiners, "painters."
6. The mill	Head mill man, planer, sawyer, and helpers.
7. Framing stage............	Stage-builders, ship carpenters.
8. Rigging loft	Boss rigger and helpers.
9. Joiner shop...............	Ship-joiners.
10. Paint shop...............	Painters and varnishers.
11. Tool house...............	Boss carpenter and gang foremen.
12. Blacksmith shop..........	Blacksmith and helpers.
13. Compressed-air house	Stationary engineer.
14. Stable	Teamsters.

The yards building wooden ships are usually laid out on the same general plan as the steel yards. Among the common features are a wide frontage on the seashore or river bank with enough space to accommodate the hulls

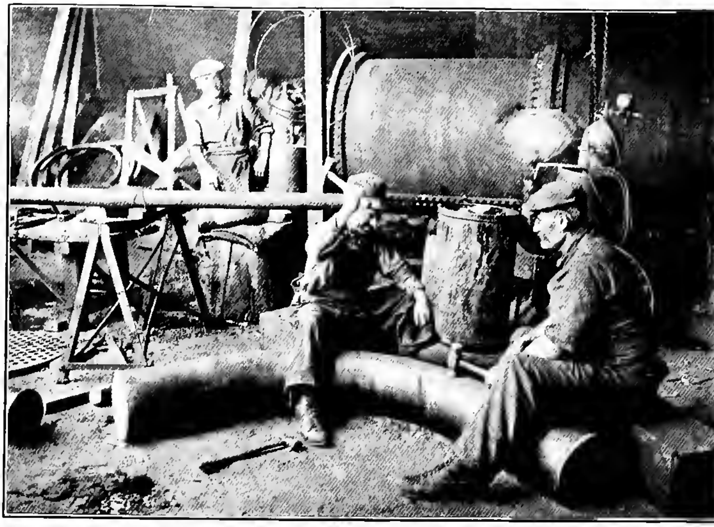
under construction, piers or wharves for unloading waterborne material, railroad sidings for lumber or steel shipped by rail, narrow-gauge lines connecting the piers and warehouses with the shipways and workshops, and aërial conveyers or traveling derricks to distribute the lumber or machinery when it is ready for the ships. Facing the line of vessels is a group of shops and two or three plants for furnishing power for compressed-air tools.

As compared with the plants for building steel ships, those for the construction of wooden vessels are usually much smaller and very much simpler in operation. The massive timbers are unloaded from scows or flat cars by traveling derricks and stacked in a space accessible to the overhead conveyers which carry the material to the bandsaw shops. After being marked from templates prepared in the mold loft, the timbers are cut to size and transferred by derricks to the ship cranes for erection on the hull.

Ample space is required for stacking the lumber upon delivery and again after it has been hewed or sawed and beveled into shape. Much of the work is done in the open air by hand, such as the hewing of the large stern posts and the rudder and bow pieces, trimming the "knees," and the preparation of booms, yards, and masts.

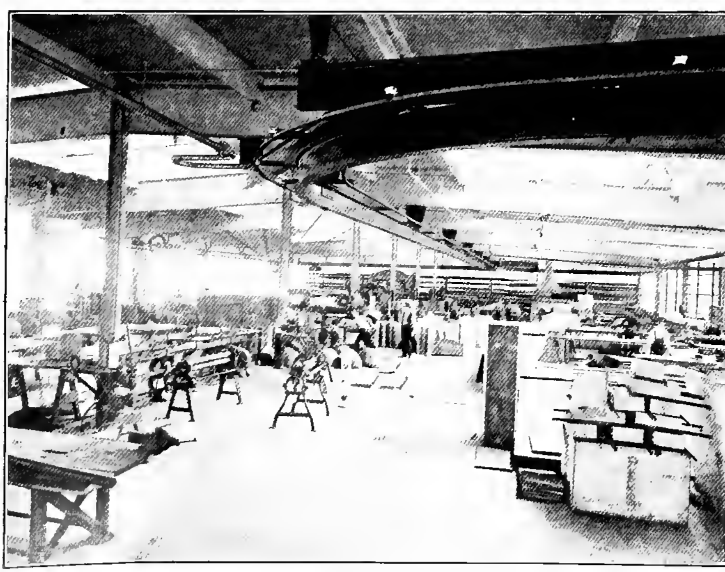
Much more yard room is demanded for wooden shipbuilding in proportion to tonnage than in the steel shipyards. In the latter case, steel plates can be stored on edge in racks and passed with very little handling to the plate and angle shops for punching and shearing.

The principles of standardization are being applied to a limited extent in the building of wooden ships of the Ferris type. The invention of labor-saving machinery and turning out timbers in quantity for hulls of a stand-



SMOOTHING THE BEND IN A COPPER PIPE

The pipe is filled with rosin before being bent, thus making it easier to work it into the required shape



A SHEET METAL SHOP

Sheet metal workers of all kinds, and especially coppersmiths, are greatly needed in the shipyards

ard size have greatly reduced the time necessary for hull construction. The Grays Harbor Motorship Corporation of Aberdeen, Washington, now holds the world's record, having completed a four-thousand-ton wooden hull in seventeen and one half working days from the laying of the keel.

Compared with steel shipbuilding or other industrial enterprises the wooden shipyard employs fewer persons, and the materials entering into wooden shipbuilding construction are simpler and much less in number than might be expected. For the same reasons office forces are smaller and there are fewer departments. A manager may be both purchasing agent and paymaster, or in a slightly larger plant there will be an assistant manager who will act as paymaster, purchasing agent, and general clerk. The number of stenographers and clerks varies with the size of the office, but the administrative end of a wooden shipbuilding plant is always relatively small. The purchasing agent, where there is one, needs to be familiar with the cost and quality of shipbuilding materials. The paymaster obviously does not need to have shipbuilding experience. There are no special requirements for clerks and stenographers, although they are likely to be more valuable if they have had some acquaintance with this particular business.

The workers in a wooden shipyard who have to do with actual construction are indicated in the following list:

1. Draftsmen.
2. The master workman, or ship carpenter.
3. Ship carpenters.
4. Hewers, liners, plankers, and bevelers.
5. Ship-joiners.
6. Calkers.
7. Blacksmiths.
8. Painters.
9. Ship-riggers.
10. Mill men.
11. Yard-riggers.
12. Teamsters and lumpers.

The draftsman and his assistants must be trained in drafting for the construction of wooden vessels. Drafting deals especially with the lines for the frame, but usually provides the boss carpenter with a drawing of the midship section. The draftsman also directs the making of the molds for the frames. All work in connection with the mold loft is highly expert and requires years of experience.

The most important factor in the construction of a wooden ship is the boss carpenter or master workman. He is personally responsible for the proper performance of all work. He is an expert in every sense of the word, and personally supervises the laying-out of the molds, the placing of the keel, the setting of the stem and stern post, and the work of the liners and bevelers. More than any other one man, he is responsible for good workmanship in the making of a vessel. He needs not only skill but years of experience in the construction of wooden vessels.

The tool house in which are stored the general supplies and the tools when not in use, is under the charge of the boss carpenter and the gang foreman. In most wooden shipyards there is no necessity for a special man to take charge of the tool house.

The boss carpenter takes the timber which has been sided in the mill and molds out the sections of frames. These are built on the framing stage by the ship carpenters. This work can be done by intelligent laborers under the supervision of experienced foremen. After the frames are built they are set in place and fastened. Intelligent laborers can be taught fastening, although it is necessary for them to work under an experienced foreman. The stage on which the frames are built is usually con-

structed by expert stage-builders. These stage-builders do all of the stage construction, keeping it up about the vessel as it develops toward completion, and also erecting more or less staging on the interior of the ship.

The inside woodwork of the hull is performed in the main by ship carpenters. As a general thing these men have been apprenticed to the work at an early age and have acquired a skill which an intelligent workman can have only after years of experience. The ship carpenter must continually use good judgment in the cutting of the timber that he is working upon. Everything must be made to fit as he goes along. Outside of the general lines and dimensions, it is impossible to stipulate just how the workman shall prepare each stick. Nothing is machine-made, nothing is stamped out for him as in steel. Wood swells, shrinks, and twists, and when using large timbers no two are just the same in dimension or quality. A ship cannot be well made unless the workmen are intelligent enough to carefully prepare and fit every piece which is put up. Some general carpenters can be made over into ship carpenters, especially if they are accustomed to heavy tools. This is best brought about by assigning such men as helpers to work along with an experienced ship carpenter.

Among the yard workmen there are hewers and bevelers. These men must be very skillful with the broad-axe and the adz. To do this work satisfactorily requires both skill and experience. The work could be done by lumbermen who have been in the habit of using such tools or by men from farms on which there has been considerable homemade construction of farm buildings.

After the frame is up it is worked over by the dubber, or hewer, who smooths the timbers with an adz so that

the planking will fit properly. After the dubbing process the planking begins. The plankers work in squads of three or four. Their work is closely watched and frequently tested by liners who see that the work is in right alignment. Liners and bevelers stand next to the boss carpenter in importance and responsibility. The work is quite difficult and requires years of training. Plankers also are expert workmen, though some in each gang may not be skilled men.

The beveler bevels all plankings and ceiling and is responsible for seams fitting perfectly.

The inside paneling for the cabins is all constructed in the joiner shop. It involves the highest grade of workmanship. The panels are built to measure and finished in the shop, and are then taken into the ship and set in place. Doors, windows, stair-rails, and similar parts are are all made in the joiner shop.

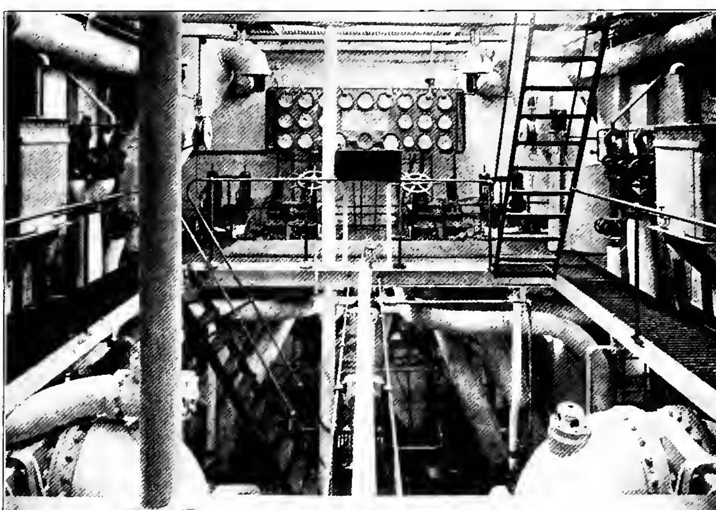
Cabinet-workers and house carpenters may learn joiner-shop work. House carpenters do not always adapt themselves easily to ship work. They are likely to feel that their previous knowledge of carpentry is sufficient, and do not realize that ship joinery and ship carpentry are quite different in the grade of workmanship required. Another great obstacle is that while house carpentry is nearly all estimated on a flat surface, nearly everything in the construction of a ship is on a bevel. Hence the ordinary carpenter finds himself at a loss to make his measurements and joints.

After calking has been completed, a gang of joiners planes the inside and outside of the ship to produce smooth surfaces in every part.

After the outside planking is on, the squarer wears it down to some degree of smoothness, using an adz for

ELECTRICIANS INSTALLING A SEARCH-LIGHT

The electrical department repairs the yard motors and lighting and power lines, and installs electrical machinery and power and lighting systems on the ships



ENGINE-ROOM OF THE S.S. MANI BUILT AT THE UNION IRON WORKS, SAN FRANCISCO, CAL.

The electrical equipment was built by the Westinghouse General Electric Company. Electricians from outside companies install all special equipment such as radio sets and switchboard instruments

this purpose. Tools driven by electricity have been devised for doing this work and their use is rapidly becoming quite general. Following the squarer is the calker who fills in all seams with cotton, oakum, and pitch. While calking requires considerable skill and judgment, an intelligent workman with a reasonable amount of supervision can learn to perform all ordinary parts of the work in a few weeks.

One of the most important workers in the shipyard is the blacksmith. He needs to be unusually expert and a skilled worker in iron, as practically all of the iron work which enters into the vessel is manufactured in the yard blacksmith shop. About 125 tons of iron enter into the construction of a 3500-ton vessel. The blacksmith makes rings, bolts, diagonal strappings, drift bolts, turnbuckles, belt straps, and other parts too numerous to mention. His helpers should be more skilled than the average blacksmith; preferably they should have machine-shop training.

Painters follow the calker and the joiner. They put on priming coats and do plain work on the hull, masts, and spars. In the paint shop some parts of the joiner work are painted and varnished before being installed in the shop. This work and the finer finishing on the ships call for expert painters and varnishers.

In the rigging loft all cables are cut to the right length, fitted, and covered. Then gangs of riggers install the ropes and cables upon the ship. For the most part, the riggers should be men who know the work. It is not easy for a common laborer to take up the occupation. As in the steel shipyard, sailors and builders of yachts and small boats make the best riggers.

A very important adjunct to the yard is the lumber

mill. The head mill man should be experienced not only as a mill man, but in working out ships' timber. The mill men must be able to run circular saws, bevel band-saws, and planers. The helpers may be men who have had experience in heavy lumber mills.

There should be in the yard crew a few men who are capable of handling fall and tackle and derricks. These men are called "yard-riggers." Men who have been in the habit of using tackle and derricks, with other similar lines of work, are capable of doing this work in a ship-yard.

In most yards the heavy hauling is done by teams. Any man accustomed to driving work horses can act as teamster. Working with the teamsters are men who are accustomed to handling lumber, loading, unloading, and piling it. This work may be performed by men who have had experience in handling lumber in mill yards or in lumber districts. Men who have worked on farms can do this work. There are also a few common laborers, sometimes called lumpers. Any strong, healthy man can do the work of the lumper.

The stable is in charge of the head teamster. In most of the large yards now under construction there is little or no teaming, steam derricks and electric cranes, and in some cases traction engines, taking the place of teams.

Wooden yards have stationary engines in their sawmills which any engineer accustomed to this kind of work can run. Yards are now using pneumatic tools to a considerable extent. The engineer who runs the compressed-air plant does not need to be especially skilled. Any man who has had experience in running a stationary engine is competent, with a little instruction, to do this work.

CHAPTER XI

RECRUITING AND TRAINING AN INDUSTRIAL ARMY

A CENTURY ago when Commodore Perry built his fleet of wooden vessels on Lake Erie, shipbuilding was a relatively simple matter. There were plenty of men among his army of sturdy pioneers who could build a ship from the keel to the topmast, and nearly all of them could swing a broadaxe, or use an adz. Abundant materials were at hand for the taking, there was no cause to worry over wage rates, and every man stayed persistently at his post until the task was finished.

Conditions to-day are very different. The shipbuilding trades are highly specialized. More than sixty important occupations requiring a high degree of skill are to be found in the usual steel yard. Even in wooden shipbuilding, the work is being subdivided more and more and apportioned to men who are skilled in only a few special tasks. Many serious problems are involved in the erection of shipways, of shops and offices and warehouses, as well as in the preparation and transportation of materials. These difficulties are relatively easy to overcome in comparison with those connected with the organization and maintenance of a stable, efficient working force in the yards. To induce men of the right type to come from all over the country to these industrial centers is the first task of the shipbuilders. Once enlisted, this army must be trained, its physical and moral welfare safeguarded, promotions planned, discipline provided for, and wage rates adjusted to conform with changing economic conditions.

The recruiting carried on by a few yards where the working force has been built up successfully with little or no Federal aid shows that there are plenty of capable men available. The Fore River plant of the Bethlehem Steel Corporation had 3700 men on its pay-rolls in May, 1917. On December 7, 1917, the total had been increased to 10,253 and by July, 1918, it was nearly 15,000.

In spite of the fact that shipbuilding has been a neglected industry in the United States since the close of the Civil War, our national habit of labor migration has created a considerable body of men who have had some experience in the shipyard trades. Especially is this true of wooden shipbuilding trades. In the spring of 1917, Mr. Denman, then Chairman of the Shipping Board, appealed to the Federal Employment Service for ship carpenters. Telegrams were sent out to sixty-four of the leading Federal agencies. Within forty-six hours the office in Washington had available the names and addresses of twelve thousand men who were experienced shipwrights. Less than two thousand could be used at that time.

For various reasons, however, this is a source of supply which cannot be depended upon. Recruiting men from occupations resembling shipyard work and giving them a short period of instruction in the yard has proved to be the only successful method.

The work of many shipyard trades very closely resembles that done by men in similar lines. Machinists, boiler-makers, pattern-makers, acetylene and electric welders, foundrymen, and galvanizers from outside industries find the tools, materials, and general operations in a shipyard quite familiar. While they cannot be expected to handle all classes of work at once, only a few

CUTTING A STEEL PLATE WITH THE OXYACETYLENE FLAME

The intense heat burns away the metal, making a clean, narrow cut

AN OXYACETYLENE WELDER REPAIRING A CRANK-SHAFT

Skilled workmen in this trade can do the work of the yards without any additional training

weeks' training are required to enable them to become efficient workmen.

With a few exceptions the remaining shipyard trades, especially where fabricated ships are being built, can be so subdivided and standardized as to allow skilled mechanics to undertake the work after a short period of experience under competent instructors. Furthermore, a large proportion of the labor in every shipyard calls for nothing more than able bodied men who are willing to do hard, heavy work.

If the matter ended with finding and training 250,000 or even 500,000 men for this enterprise, it would present no very grave difficulties. But this is only the beginning. Strikes are usually greatly feared as a cause for unemployment, reduced production, and industrial upheavals. A cause for apprehension of much greater consequence to our shipbuilding plans is to be found in what has recently come to be known as "labor turnover." By this is meant the shifting of employees from plant to plant and from job to job. Technically, it is taken to mean the percentage obtained by dividing the number of persons leaving the employ of the company during the year by the average number employed in the organization.

At a conference of employment managers and welfare workers from the shipyards held in Washington in November, 1917, it was stated that many of the yards were then hiring from seventy-five to one hundred new men every three months for every one hundred employees on their average pay-roll. The figures compiled by the Emergency Fleet Corporation for the early months of 1918 indicated that the turnover for both wood and steel yards was averaging about two hundred per cent annually. Figures were compiled in November, 1916, before

the war crisis appeared, from one of the yards under exceptionally good management. It was found that more than half of the three thousand men employed had been with the company less than eleven months. Facts of this sort mean that unless measures are taken to prevent it, more than a million men will have to be engaged each year for a greater or less length of time in shipbuilding in order to maintain an average working force of five hundred thousand.

No one knows exactly what it costs to hire and train the average workman in a shipyard, but the figures obtained from other industries can be taken as a fair indication of the amount. For unskilled labor, it runs from five to ten dollars per man, while the total cost of replacing an expert workman varies from thirty to two hundred dollars. The loss of a valuable foreman may cost the plant several thousand dollars.

The time and money thrown away in training these men, in finding and hiring them, the falling off in production due to the work of inexperienced persons, and the waste of idle machinery, when added up represent losses which are appalling. Merely transporting so many persons from place to place is a large item and throws an additional burden on our common carriers. If these conditions obtained only in the shipyards, the matter would be of relatively slight consequence. But such is decidedly not the case. Employers, everywhere, and especially large manufacturers, face exactly the same situation.

Not all of this waste can be saved. In spite of careful initial selection, a few are sure to be discharged on justifiable grounds and others withdraw for unavoidable reasons. Even in the army training camps, a certain number of losses must be anticipated from natural causes.

Accidents, disease, and death are certain to account for four or five per cent each year. Probably under ideal conditions, twenty-five or thirty out of every one hundred employees must be replaced each year.

What are the reasons for the remainder of the shipbuilding "turnover," and how can it be avoided?

Seeking more attractive wages lies at the heart of much of our labor migration. Scamping, or the practice of attracting men from other yards by offering higher wages or other inducements, was prohibited some months ago in the navy yards by an executive order. More recently, an agreement was entered into by the yards on Government contracts which requires a man who comes from similar work elsewhere to furnish a release from the Federal or State Employment Bureau in the district where he was last employed. To adjust disputes arising out of wages and working conditions, the Shipbuilding Labor Adjustment Board was created. Its main object was to remove the inciting causes for the shifting of men from yard to yard. After a long series of hearings, this board has now established uniform wage scales for all of the shipyard trades.

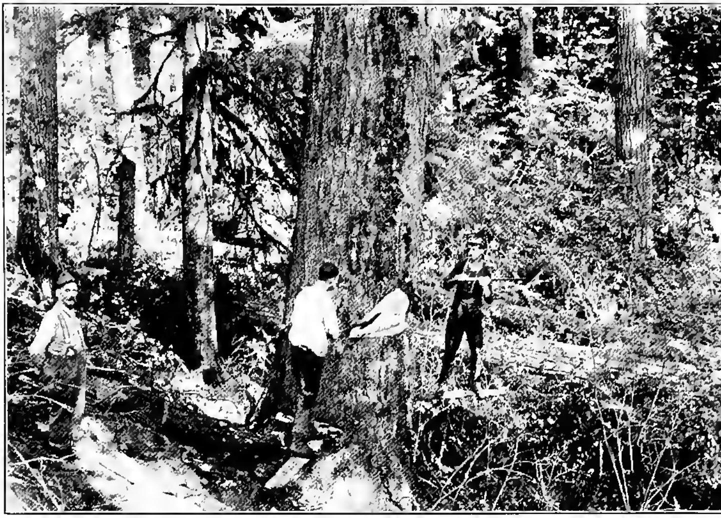
Another cause for discontent among shipyard employees arises from leaving the functions of hiring, promotion, and discharge in the hands of foremen. Overtaxed as they are by the attempt to speed up production, it is impossible for them to find the time or energy necessary to properly select men or care for their training and general welfare. The same factors which produce frequent changes of occupation among employees in other trades may be expected in shipbuilding. Putting men on work for which they are unfitted, accidents, sickness, poor transportation to and from work, lay-offs due to

bad weather or lack of materials, personal disagreements with other workmen or with foremen, all contribute their quota. Only by centralizing the task of dealing with these questions in a separate department, can proper attention to them be secured. Experience in industrial establishments of every kind has proved the wisdom of removing such duties from the foremen and placing them in the hands of men specially trained and qualified to discharge them.

The importance of this step is further demonstrated by some of the difficulties which faced the shipbuilders during the first year of the emergency programme.

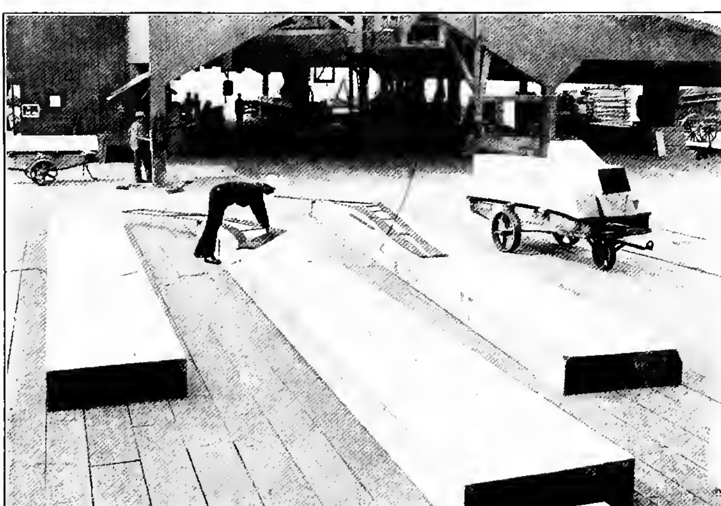
Because of the heavy outdoor labor involved in many of the shipbuilding trades, nourishing food is essential if the men are to render efficient service. At first, very few of the companies had restaurants or lunch-rooms either in or near the plant where the men could be accommodated. Cafeterias are now being built and much improved facilities are to be found in nearly all of the yards.

The lack of physicians, nurses, and hospitals or first-aid rooms has been until recently a serious drawback in many shipyards. Physical examinations for all applicants, free medical advice to employees, and surgical and medical treatment for emergency cases, will save the labor of several hundred men annually in every yard. While shipbuilding is not necessarily a hazardous occupation, minor injuries are sure to occur just as they do in construction work or in shops of any kind. Unless these injuries can be treated promptly, infection sets in and serious complications result. In addition to this service, many of the plants are now providing examining physicians whose duty it is to encourage applicants to secure prompt treatment for minor complaints and to bar



LOGGING IN A FOREST OF DOUGLAS FIR

In April, 1918, fifty million feet of this timber was sent from Oregon and Washington by special trains to the wooden shipyards of the Gulf and the Atlantic



MARKING THE TIMBERS FOR CUTTING

Templates similar to those used in steel shipbuilding are prepared by loftsmen for this purpose

from the yards men who are physically unfit to attempt the work.

All of the larger yards at first experienced serious transportation difficulties. In many cases special street car lines or spur tracks were built to accommodate the workmen. It frequently happened that several months elapsed before adequate provisions could be made.

There is almost unanimous approval of the efforts being made to preserve high moral standards in the army, both at home and abroad. Gathering thousands of transient workmen into the shipyards, housing them in barracks, and paying them high wages are likely to give rise to deplorable moral conditions, to say nothing of the wasteful loss to ship production, unless thoroughgoing preventive measures are adopted at once. Drunkenness and vice are frequently causes of high labor turnover as well as absence from work; the shipyards have suffered from these causes even more than other industries because of the higher wages paid.

The most serious of these conditions are rapidly being improved. The Merchant Shipbuilding Corporation at Bristol, the New York Shipbuilding Corporation, and Hog Island are examples of yards that are building excellent cottages for their employees. Splendid coöperation is being given by the Y.M.C.A. and other agencies in improving social conditions among the men.

No one ought to be misled, on the basis of the facts pointed out above, into a criticism of the work being done by the Shipping Board or its assistants. They have probably done all that is humanly possible up to the present time. The majority of the deficiencies suggested have become urgent since the rapid increase in the size of the yards took place. It ought also to be understood

that these are questions of far reaching importance to the general public. They affect industries of every kind. Only by the persistent efforts of loyal citizens everywhere can effective answers be found.

Some very valuable service in reducing labor turnover has been rendered by the National Chamber of Commerce and incidentally by the press. The widespread publicity given to the emergency shipping programme has had a distinct effect in strengthening the morale of the workmen. Medals to be worn by shipyard employees, and addresses of a patriotic nature given in various plants during the noon hour have proved helpful in getting the men to realize the significance of their tasks. By a recent expansion of the Federal Employment Service under the Labor Department, the yards have been relieved of much of the burden of recruiting men. Since August 1, 1918, all unskilled labor has been provided by Government employment offices, and they have already supplied many of the skilled mechanics who were formerly secured by advertising, or scouting, or other expensive means.

The fact remains, however, that the most important part of the task of selecting and holding employees must be accomplished by the individual yards. Only by careful analysis of the local situation, carried on by persons who are expert in handling men, can satisfactory plans be made for the details of hiring, promotion, discharge, transportation, housing, and health and safety supervision. To help the shipbuilders throughout the country in dealing with various labor questions, the Industrial Relations Group of the Emergency Fleet Corporation was established.

The two subdivisions of this group which deal with the

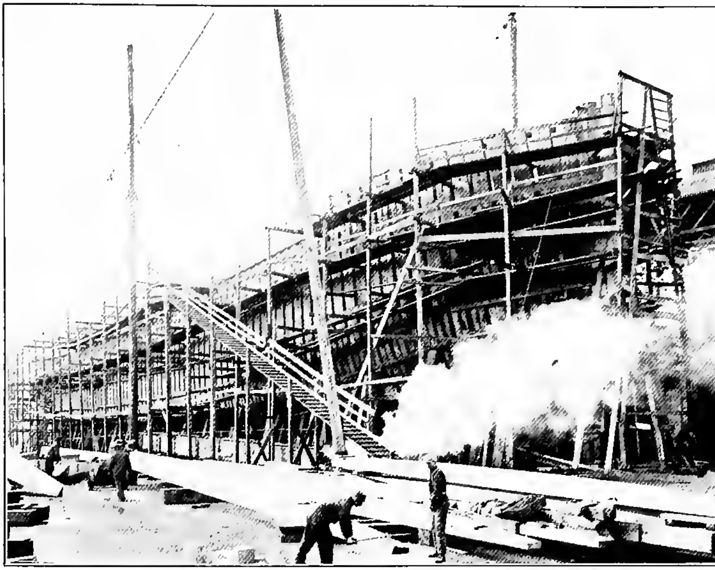
employing and training of shipyard workers are the Industrial Service Section, and the Education and Training Section. The former supervises the collection and interpretation of statistics relative to labor in the yards. It also coöperates with the yards in training service and employment managers, holds district conferences with foremen, employment managers, and superintendents and makes special studies of the labor needs of each plant. The principal function of the Education and Training Section has been training instructors for the shipyard trades.

Among the causes which are responsible for the creation of these sections is the recognition of the need for a closer study of the costs involved in the inefficient management of labor. The employment manager may be regarded as a cost accountant of labor. He studies the cost of labor turnover, of accidents, of sickness, of improperly placed men, of tardiness and absence, as well as of strikes and lay-offs. The organization of a service department in any industrial plant does not mean an increase in the cost of doing business. On the contrary, it means an economy in the time of foremen who are thus enabled to devote their entire attention to production. It means better qualified employees and therefore more output. It means a reduction in the number of accidents and in the amount of ill health. Best of all it means just standards of work and wages and better adjustments of grievances. Other industries have recognized the value of such a department and it is only logical to anticipate its success in connection with shipbuilding.

There should be no misconception as to the nature of this work. It has nothing in common with palmistry, physiognomy, phrenology, or any occult science. The

success of the best employment departments has arisen almost wholly from common-sense methods applied to the study of working conditions and of the special qualifications required to enable a man to fill a given position acceptably. By centralizing the personnel functions of management under one capable head, and insisting upon a critical analysis of the causes for excessive leaving and discharge, firms like the Dennison Manufacturing Company of Framingham, Massachusetts, the Curtis Publishing Company of Philadelphia, and Thomas A. Edison (Inc.) of West Orange, New Jersey, have been able to reduce the annual labor turnover to forty-five per cent or less. These achievements should be bettered in the shipyards under the stimulus of the nation's emergency.

Largely as a result of the efforts of the Emergency Fleet Corporation many of the shipyards have established employment and service departments, in which the work is being organized along highly commendable lines. As an example, the American International Shipbuilding Corporation of Philadelphia in June, 1917, employed an expert to study employment problems and make recommendations for improving conditions in the New York Shipyard. After a study of the local situation, an employment bureau was established which has charge of the selection of all men who apply, the transfer of employees from one department to another, and the investigation of each case of discharge or voluntary leaving. Medical examinations were introduced as one of the means of deciding upon the man's ability to undertake the work for which he applies. If a workman desires to resign, or is discharged by a foreman, his case is fully investigated by the employment office, and an attempt is made to adjust conditions. If a satisfactory agreement



THE FRAMES OF A WOODEN SHIP

Smoothing, or "dubbing," the outside of these frames was formerly done entirely by hand, but power machines are now in use for doing the greater part of this work

MAKING A SCARF WITH THE BROADAXE

The keel, or keelson, timbers are carefully scarfed by skilled workmen

can be made, he returns to work. Very often the man is physically unequal to the task or the difficulty proves to be a personal one between the man and his supervisor. In such cases a transfer to other work or to another department is made.

Under the direction of Miss Lillian Erskine, Specialist on Industrial Diseases for the State of New Jersey, plans were drawn for a cafeteria with seating capacity for 1800 at one time. Locker space, laboratories, smoking-rooms, and other conveniences were provided for the company's employees. A restaurant for the office force, where meals are sold at cost, and a rest room for the female employees of the office, are other features of this service. A group insurance policy which covers all men who have been employed by the corporation one year or more, regardless of age, has been instituted. The policies issued range from $500 to $2000 per man. More than 4000 employees have already availed themselves of this opportunity and have taken out insurance. Recreation has been provided in the form of football, soccer, baseball, cricket, and tennis. The company furnishes the grounds and puts them in condition; it also buys the necessary athletic equipment and in other ways stimulates interest in athletic sports. A brass band of forty-six pieces has been formed under capable leadership, and frequent concerts are given for the enjoyment of hundreds of workmen. A hospital has been in operation for some time. Under the new management, this was reorganized and more fully equipped. Free medical advice is now given to all employees, in addition to first-aid service for all injuries to workmen while on duty in the yard.

The Submarine Boat Corporation of Newark, New Jersey, makes a special feature of holding men in tem-

porary employment until they can be transferred to the kind of work for which they are best fitted. Before taking on new men, transfers are made of those who can be spared from the departments in which they are working, or who properly belong in the work for which a call for additional help comes. In this way many good men are secured and are placed to very much better advantage than is possible where men are merely taken on to fill immediate vacancies. Provision for housing at Newark has been made by a thorough canvass of every available house, boarding-place, and room in the immediate vicinity. Applicants for positions are kept over night if necessary, or boarding-places are secured for them at once.

The Chester Shipyard at Chester, Pennsylvania, has a corps of men whose duty is to take new employees into the yard, show them the work they are to do, introduce them to the foremen, explain the method of punching the time-card, and show them the location of lockers, lavatories, and tool rooms. Every possible effort is made to insure the right kind of instruction for each man so that he may undertake his new tasks intelligently.

A very complete and modern service building has just been erected for the Merchant Shipbuilding Corporation at Bristol, Pennsylvania. The applicants for positions enter a comfortable, well-ventilated reception room where they are met by a preliminary interviewer. This man is a graduate of Wisconsin University, thoroughly familiar with shipyard conditions, and fluent in the use of four different languages. He rejects applicants who are manifestly undesirable for any of the positions open and directs the others to one of the rooms occupied by the three regular interviewers. Each of these interviewers hires for a particular group of shipyard trades. They are

all mature men, carefully chosen for their judgment in selecting and placing employees. Every effort is made to put the applicant at his ease and to get a fair account of his experience and ability. Those who are accepted by the interviewers are passed into the next room where their application blanks are filled out by a group of clerks, most of whom are middle-aged women. Skilled mechanics are taken into the yard by a guide for an interview with the foremen, who make the final decision as to their qualifications. They then follow the other applicants through the routine of medical examination and photographing for the identification pass. Elderly men who are thoroughly familiar with the yard act as conductors in acquainting the new employees with their work places and the necessary information to begin the daily routine of the yard.

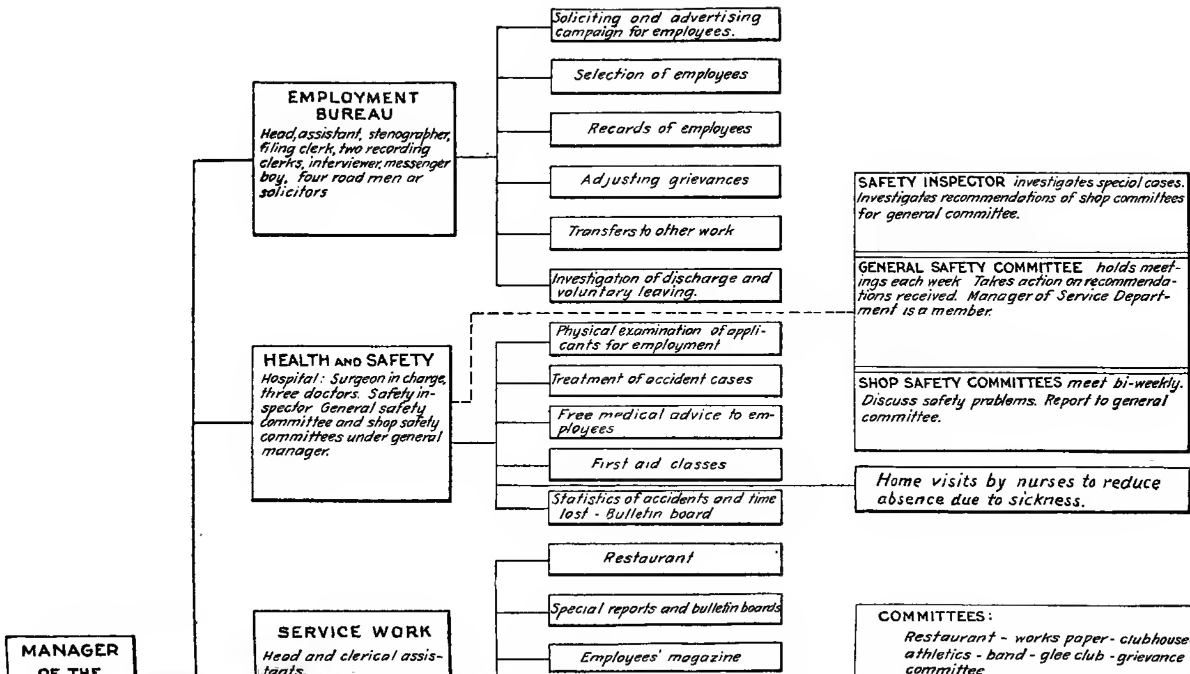
The service building contains a fully equipped first-aid room, a small hospital, and the offices of the safety inspector and the editor of the "Merchant Shipbuilding News," an interesting weekly published for the employees. An important feature of this Service Department is the adjustment bureau presided over by a genial yet canny Scotchman who was formerly a Congregational minister. He adjusts all complaints, interviews those who are absent or tardy, investigates cases of discharge and attempts to turn back into the employ of the company those who are voluntarily leaving.

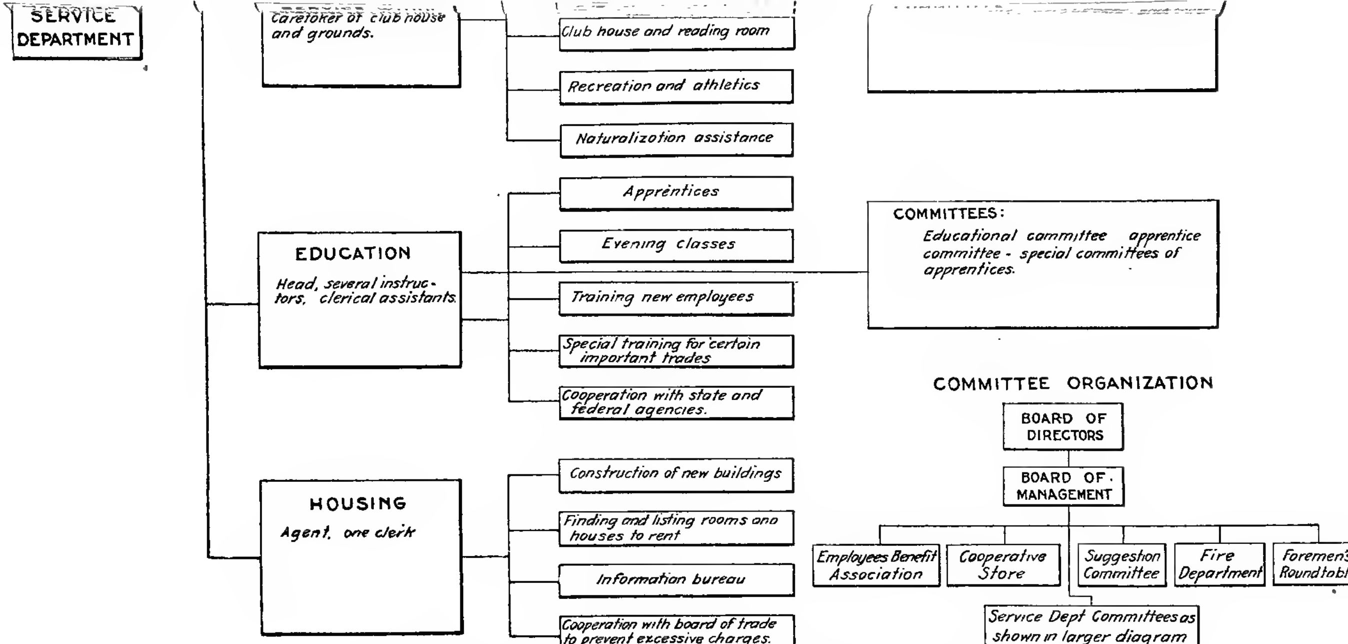
The navy yards have a somewhat different employment problem from that presented by the private shipyards. Civil service regulations determine the conditions of work, pay, and the terms upon which men are accepted by the yards. As a rule, only two classes of unskilled workers are taken: laborers who are not likely to become

proficient in any of the skilled trades, and general helpers who can be trained to some of the shipbuilding trades. There is no permanent place for unskilled workmen.

The chart on opposite page represents the activities of a typical service department. At the head of the department is the service manager, a man who must be well trained and capable of occupying a position equal in importance to that of the head of the purchasing or production division. Associated with him are the heads of the five bureaus: employment, health and safety, service, education, and housing. Each of these persons is responsible for a different series of duties, the nature of which is clearly indicated by the chart. In addition to these members, the department may also include the following: Interviewers who talk with applicants and decide upon their qualifications; physicians, surgeons, and nurses who examine applicants, treat accident cases and minor illnesses, and give medical advice; a safety engineer who guards machinery, gives instruction on safety first, and attempts in various ways to discover the causes for accidents and prevent them; caretakers and employees for restaurants, club-rooms, reading-rooms, and coöperative stores; instructors for apprentice schools and for the training of new employees; clerks and stenographers who file records, fill out application blanks, and care for the correspondence of the department; directors for athletics and music; an editor and assistants in charge of the weekly or monthly employees' bulletin or journal; a photographer who makes the photographic passes required of each employee; a counselor who gives free advice on legal matters.

The best managers for service departments are those who have a sympathetic understanding of the problems


MANAGER
OF THE
EMPLOYMENT BUREAU
Head, assistant, stenographer, filing clerk, two recording clerks, interviewer, messenger boy, four road men or solicitors
Soliciting and advertising campaign for employees.
Selection of employees
Records of employees
Adjusting grievances
Transfers to other work
Investigation of discharge and voluntary leaving.
HEALTH AND SAFETY
Hospital: Surgeon in charge, three doctors. Safety inspector General safety committee and shop safety committees under general manager.
Physical examination of applicants for employment
Treatment of accident cases
Free medical advice to employees
First aid classes
Statistics of accidents and time lost - Bulletin board
SAFETY INSPECTOR investigates special cases. Investigates recommendations of shop committees for general committee.
GENERAL SAFETY COMMITTEE holds meetings each week Takes action on recommendations received. Manager of Service Department is a member.
SHOP SAFETY COMMITTEES meet bi-weekly. Discuss safety problems. Report to general committee.
Home visits by nurses to reduce absence due to sickness.
SERVICE WORK
Head and clerical assistants.
Restaurant
Special reports and bulletin boards
Employees' magazine
COMMITTEES:
Restaurant - works paper - clubhouse - athletics - band - glee club - grievance committee



THE WORK AND ORGANIZATION OF A SERVICE DEPARTMENT

affecting the worker and who also possess the ability to acquire new ideas and a scientific point of view such as a college education is likely to give. While not essential, college courses in applied psychology, business administration, economics, and sociology are helpful. Candidates for these positions should have had at least three years' industrial experience either in a factory or in some large enterprise, a part of which ought to be spent in contact with shop or operation problems. This experience should have made the candidate familiar with factory tools, machinery, equipment, materials, and processes. He should appreciate the significance of life in a large organization; he must know what factory discipline signifies, what the schedule of hours means, what the attitude of the worker is to his job, his boss, his fellow worker, and to life in general. One of the most important qualifications, either for the service manager or for the head of the employment bureau, is the ability to judge human nature. And this ought not to be merely a superficial readiness in judging personality and fitness for special jobs, but a deeper understanding which will permit him to weld a great organization into a stable, harmonious whole. In the real sense of the word, he is called to industrial *service* as the exponent of the best interests of the workman on one side and of the management on the other. He is not expected to extend paternalism or to make gifts to the employees, but to discover better opportunities for them and to protect their rights.

Much of the responsibility for a successful employment bureau rests with the interviewers. Upon their ability in selecting men for vacancies as they arise depends not only the contentment of the employees, but also the success of the plant as a producer. They ought to be true

vocational counselors, capable of offering helpful advice to those who are unfit for the positions for which they apply. Men are needed who are tactful, courteous, direct, keen in their analysis of experience and physical and mental qualifications, and fully aware of the requirements of the various shipbuilding trades. A sympathetic understanding of the applicants' problems and of his limitations is quite essential.

Properly qualified industrial physicians are especially difficult to find. The examiner and the first-aid surgeon by their tactful and cordial treatment of employees can accomplish a great deal toward building up a wholesome and harmonious spirit in the organization. If the physician will take the trouble to acquaint himself with the different shipyard trades and with the working conditions, he can render very valuable assistance to the employment office in placing applicants to the best advantage.

A capable nurse can render equally important service. Among her activities are the treatment of minor injuries, assistance in the hospital, and home visiting. The Chester Shipbuilding Company employs several nurses who are furnished with Ford cars to enable them to visit the homes of men who are absent or frequently tardy. Excellent results have been attained in improving health conditions and in giving aid to families where the wife or children are ill.

At present, the chief obstacle to inaugurating better systems of employment supervision not only in the shipyards, but in other large industries as well, lies in the lack of trained employment managers. Although a few educational institutions have realized the demand for trained workers in this field, the courses so far offered have usu-

ally been merely descriptive and theoretical. To meet the emergency demand in shipbuilding as well as in other war industries, special practical courses have been organized by the Employment Management Division of the War Industries Board. Through the coöperation of a number of departments at Washington, including the Ordnance Department, the Quartermaster's Department, the Navy Department, the Department of Labor, the Emergency Fleet Corporation, the General Staff, and other divisions of the Government, there has been created an advisory committee to set the general standards of instruction. Each course lasts for six weeks, the time being divided among lectures, visits to service departments, reading, and class discussions. Among the topics treated are the following: The organization and methods of service departments; labor economics; the principles of industrial organization and management; statistics as applied to employment problems. The services of the foremost instructing authorities of the country in the subjects dealt with have been secured. Courses have been located at points where universities and industries can coöperate: such as Boston, New York, Rochester, Pittsburgh, Seattle, and Berkeley, California.

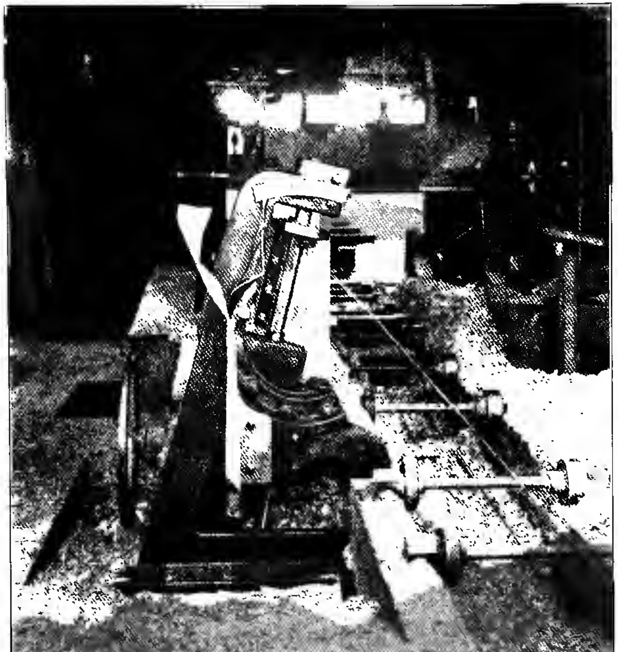
To these courses the shipyards and other employers are invited to send men or women of their own choosing, subject to the approval of the Division. It is understood that such candidates are to return to their sponsors, and be utilized by them in employment work. In each of the courses conducted thus far there have been present men of mature experience, who have taken the opportunity to review their policies and practices in the light of systematic knowledge. There have been present, also, younger persons intending to specialize upon interviewing, labor

accounting, wage setting, or other branches of practice, so as to fit themselves for special positions in employment departments.

These courses are also open to a limited number of persons, who desire to become employment executives, but who have not a definite connection with any company. Such unattached students constitute a reserve, which the Division recruits for the purpose of satisfying the demands for trained executives made upon it by Government departments and private employers.

It is only in recent years that large industrial enterprises have appreciated the importance of training men and women for their work. The lack of any adequate means for instructing foremen and other executives has been pointed out in Chapter IX. While more attention has been given to developing skilled mechanics, the instruction offered has usually been poorly organized and the progress of the beginner has been largely dependent upon his own unaided efforts.

Trade schools, technical and manual training schools, and a few technical institutes have offered shop courses and work in mathematics, science, and mechanical drawing which are helpful to one entering a few of the shipbuilding trades. In a few cases evening or part-time courses for shipyard employees have been organized either in the yard or in some neighboring school. Thus at Quincy, Massachusetts, the Quincy Industrial School has conducted evening trade courses for apprentices and helpers which are closely related to the work done during the day in the Fore River Shipyard. Different classes have studied the following subjects, among others: mechanical drawing, mathematics, practical machine work, plumbing, electricity, naval architecture, sheet-metal



A BEVELING MACHINE USED FOR BEVELING PLANKING, CEILING, AND OTHER TIMBERS

The rapidly revolving knives do the work of several hand workmen. This is only one of several recent inventions which have greatly speeded up production in the wooden shipyards

work, coppersmithing, and mold-loft practice. Evening classes are now being organized in a large number of centers in various parts of the country by the Federal Board for Vocational Education.

Many of the leading men now engaged in shipbuilding gradually acquired a knowledge of their trade by beginning as helpers and working their way up to good positions. Others were trained by the apprentice system which is still being used to a limited extent in many of the private yards as well as in the Government navy yards.

Because so many of the trades were peculiar to shipbuilding it was formerly the practice to give considerable attention to the training of boys through apprenticeship rather than to depend upon the outside supply of skilled workmen. In fact, in certain occupations such as that of hull draftsman, mold loftsman, layer-out, shipwright, or ship-fitter, it was absolutely necessary for shipyards to train their own workmen. In the yards where this work is well organized, an apprentice supervisor is appointed whose functions are to take care of new boys, and to devote himself to the best interests of the apprentices during their terms. He sees that the efforts of instructors, leading-men, and foremen are applied to the best advantage, to the end that capable young workmen of good character are produced. Provisions are usually made so that the apprentices have the best possible opportunity to learn the trade, that is, to work with a first class workman rather than a helper, and to attempt a variety of work rather than to stay at one operation continuously.

The period of apprenticeship is ordinarily four years. Systems of pay vary slightly, but it is a common practice to begin at a rate amounting to about one dollar per day

and to make an annual or semi-annual increase of a few cents in the hourly rate.

After a period of probation, generally six months, an apprentice contract, which sets forth the terms of apprenticeship, is signed by the apprentice and the concern. In order to encourage the apprentice to complete his term, a bonus and a diploma are generally offered for satisfactory service. Evening classes are sometimes conducted for the special benefit of apprentices and time credit is given for attendance.

For the training of highly skilled mechanics, engineers, estimators, and draftsmen, coöperative courses arranged between the yards and universities or institutes of technology have proved very successful. The employment department of the Harlan and Hollingsworth plant drew up a plan by which a group of men was brought from Cornell University to undertake training in the yard during the spring of 1918. These men were in the senior class of the engineering courses. Because of the great variety of experiences to be derived from the numerous shops and the many classes of work represented by a shipyard, it was felt that students in such courses could obtain an excellent opportunity for practical experience.

Two divisions were made of these students. Those who were primarily interested in mechanical engineering went into the engineering department. There they became accustomed, in the course of a few months, to the assembling and erection of machinery, or such work as boiler testing, trial trips, and other experience that would probably take three or four years to obtain in the ordinary way. Those who were interested in structural steel work, or in drafting, went into the drafting-room, or into the mold loft. Some of them were taken on as ship-fitters.

In the evenings, special lectures planned to follow up the work done during the day were given by college professors and practical men in the shipbuilding industry. These lectures were also open to foremen, leading-men, and others in the yard who seemed capable of profiting by them.

Girard College has a similar coöperative arrangement with the Chester Shipyard at Chester, Pennsylvania. The students selected for the shipyard trades are taken from the Technical School of the college. They are divided into two groups of fourteen students each, which alternate for shop practice at the plant every two weeks.

In the selection of the trades to be studied at the shipyard, special consideration is given to the student's previous training and shopwork at the college. The trades selected and the number of students in each are as follows:

Trades	*No. of students*
Pattern-makers	2
Marine machinists	6
Machinists	4
Ship-fitters	5
Blacksmiths	2
Joiners	4
Loftsmen	3
Electricians	2

The shopwork of the student is inspected at intervals during the day by the supervisor in charge. The hearty coöperation of the managers, foremen, and workers has been one of the important aids in making the plan a success. A day's work is eight hours in length and is paid for at the rate of thirty-three cents per hour.

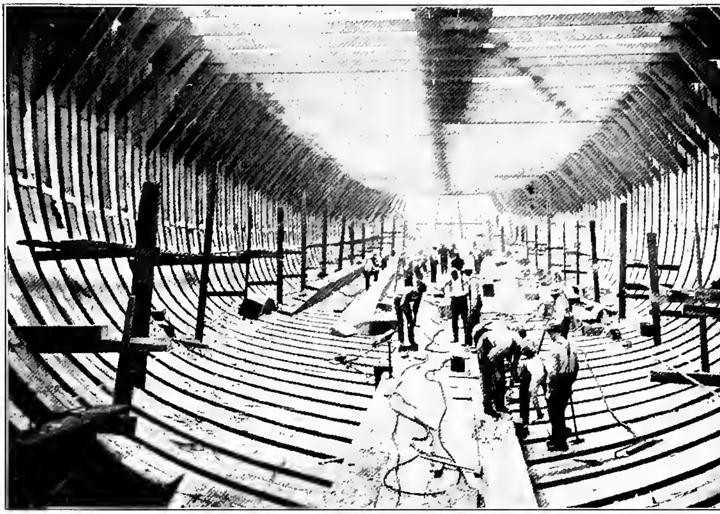
In connection with the shopwork each student is required to submit a daily report giving an account of his work, experience, and observations. This daily report is considered essential to the student's progress, as he is re-

quired to explain the terms and processes used in connection with the job upon which he is engaged. This tends to keep the young man alert and forces him to ask questions about everything that comes under his observation. The report is corrected, typed, and copies are given to the student, to the foreman of the shop and to the authorities of the college. It also serves as a record of the student's progress and as a lesson paper.

The general progress of these students, and their spirit of enthusiasm and patriotic endeavor to be of service to the country and themselves, have won for them the entire good-will and approval of the officers of the plant. They are forging ahead at a rapid rate to become efficient leaders in the production of ships.

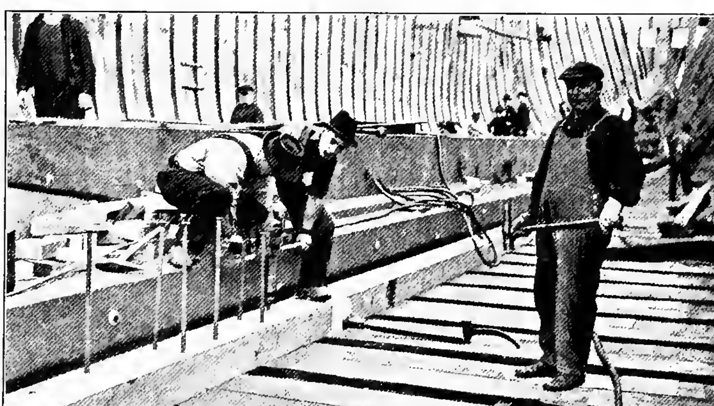
None of the customary methods of instruction were adapted to training men rapidly and in large numbers. To meet the extraordinary demands for skilled workmen, which have attended the expansion of the shipbuilding industry, special courses were designed by the Emergency Fleet Corporation. In planning this work a study was made of all the shipyard trades and of other closely related occupations. The result of this analysis showed that there was a small number of shipyard trades which could be entered by men from similar outside work with little or no instruction in addition to that which could be given very readily by the foremen or leading-men. The following workmen belong in this group:

Acetylene welder and burner.
Boiler-maker.
Core-maker.
Die-sinker.
Driller and reamer.
Electric welder.
Galvanizer.
Machine operators in steel mill or ship shed.
Machinist.
Molder.
Painter.
Pattern-maker.
Yard-rigger and crane man.



LAYING THE KEELSON TIMBERS ON A WOODEN HULL

These timbers run lengthwise of the ship above the keel



DRIFT-BOLTING KEELSONS

The keelson timbers are drift-bolted to the frames and floors by means of air hammers. One-inch iron or steel drift-bolts about 30 inches long forced in with an air hammer are employed

A second group was distinguished for which there were corresponding outside trades, but to do good work in the shipyards, the outside mechanic would require some additional instruction in shipbuilding methods. The workmen listed below are of this kind:

Blacksmith.
Chipper and calker.
Coppersmith.
Outside machinist.
Plumber or pipe-fitter and other trades in the pipe shop.
Riveter.
Ship electrician.
Ship-joiner.
Sheet-metal worker.

There were found to be still other shipyard trades for which the training would have to be secured almost wholly in connection with shipbuilding. While there were outside trades which would give certain elements of knowledge or skill which would be useful, success in these occupations depends very largely upon special experience which can be gained only in the shipyards. The most important workmen in these trades are as follows:

Anglesmith.
Mold loftsman.
Plate and shape furnace man.
Rigger.
Sailmaker.
Ship-fitter.
Shipwright or ship carpenter.
Wood-calker.

Intensive training was then planned which would prepare men for the trades named in the last two of these groups. It was apparent that the only way to get enough employees in a relatively short time was to subdivide the trades and teach men to perform special tasks. The time was too limited to acquire anything like a complete mastery of the various parts of any trade.

Naturally the only men who were in any way qualified to give instruction of this kind were the skilled mechanics already employed in the yards. The majority of

these men, however, had no training or experience which would enable them to select the parts of the work which should be taught, nor did they know how to teach others. The first step, therefore, was to provide training which would enable experienced mechanics to qualify as instructors. The shipyard at Newport News was offered as a laboratory and a corps of instructors for this unique normal school was brought together. The faculty consisted of men of industrial and technical training with several years of teaching experience. Their students were men sent from shipyards in various parts of the country, who had been selected because of their adaptability for the work of breaking in new workmen. The course consisted of six weeks of intensive study of the problems involved in analyzing the tasks of the shops and of ship construction from the point of view of the learner. These mechanics, already skilled in their trades, were taught how to organize practical shipyard instruction courses, how to find the parts of a given job which would cause the beginner most difficulty, and how to arrange the work of their students to the best advantage. At the close of the course, these men returned to their several yards and began the work of training the recruits who were being brought in by the employment departments.

Courses of this kind have been continued regularly at Newport News and additional classes have been organized in other yards. In August, 1918, there were twenty-three such instructor-training centers in operation. Nearly four hundred instructors had taken the courses and were engaged in training workmen in the yards.

The training school at Hog Island has eighty-five instructors with eight hundred men enrolled. It is expected that over two thousand men will be in training at this

school in the near future and with this in view, eighty-seven additional instructors are being prepared.

The school is specializing on riveters, holders-on, rivet-heaters, chippers and calkers, drillers and tappers, crane men, linemen, and ship carpenters. Applicants for the course in ship carpentry must be experienced house carpenters and be able to undergo a thorough physical examination. For all other trades no particular experience is necessary, the requirements being that a man pass a thorough physical examination, be able to do hard manual work such as is found in the building of steel vessels, and have an ordinary amount of intelligence.

It is generally recognized that to train a large industrial army composed of raw recruits, it is better that training be given while the workers are producing rather than to give them preliminary training in schools separated from production. The principle here involved is that a man should be a producer during his learning period.

The length of time which must elapse before a man can be transferred from the rolls of the Training School to the Ship Construction Department depends a great deal upon the ability of the man to do the work properly, as his work has to be approved by a foreman of the Construction Department before a transfer can be made.

The efficiency of these shipbuilding schools is described in a most entertaining way by Mr. Frank Johnson, a former high-school instructor, who learned the riveting trade at the Merchant Shipyard at Bristol, Pennsylvania. His story is given in the "Merchant Shipbuilding News" for August 16, 1918:

Five weeks ago I was a dignified high-school professor — clean shirt; white collar; shell-rimmed glasses; soft, flabby

muscles, and all the other earmarks of the quiet and reserved scholar.

To-day the classroom is a memory. The clean shirt is now a blue jumper. The white collar has given way to a bare, tanned neck. Safety goggles have replaced the tortoise-shell glasses, and the soft, flabby muscles are now quite hard from the constant handling of the gun of my new trade — riveting.

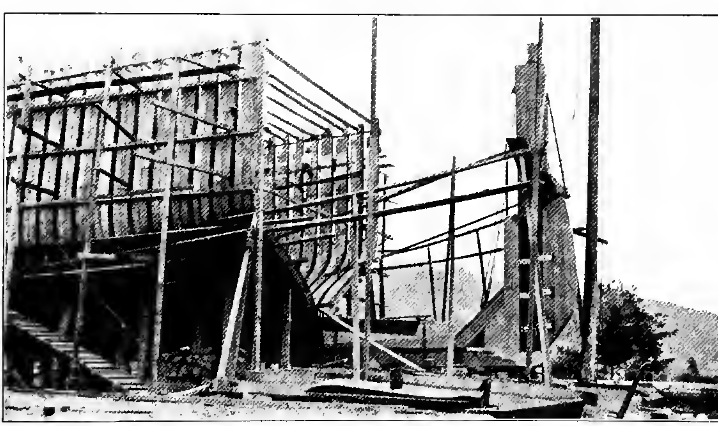
Five weeks ago I entered the yard of the Merchant Shipbuilding Corporation and made application as an apprentice riveter. I was given the "once-over" and promptly advised that my chances of qualifying were rather slim, due to my inexperience and especially to the fact that I had not done active hard work for many years. My persistence, however, finally brought me to the office of Mr. N. C. Miller, the training director, who must have seen some possibilities in me, for he gave me a little more consideration, felt my muscles, and told me he would give me a chance.

The first time I picked up a riveting gun I thought it weighed two hundred pounds, and I began to form visions of myself going back as a school teacher again. After the instructor had shown me how to operate the gun with the pressure of my thumb, he called for a heater boy and showed me how to drive a button-set rivet. After he had driven a few he passed the machine to me, and told me to go to it. I did. The hammer seemed to jump all over the entire plate, and to hit every square inch of it with the exception of the rivet head at which I was aiming. Incidentally, the only part of the plate which my free hand seemed able to touch was the hot rivet points on which I had just got through working. To my surprise, however, my muscles rapidly hardened under the training plan which is in operation, and I soon found that I could hold the riveting hammer with but little difficulty. Progress was then rapid, because each time I made a mistake it was called to my attention by the instructor and the correct method explained.

Sore muscles and burned and blistered hands troubled me a great deal, as they do all apprentices. Dodging pistons shot out of the "guns" of the other beginners is the rather precarious sport which we all indulge in, but only once was I unsuc-

CALKING THE DECK

Usually one man works alone, but in some cases two men are employed, one to handle the chisel and the other the maul. All seams are made tight with cotton, oakum, and pitch



STERN FRAMES AND THE RUDDER

The stern framing of a motor ship under construction at the plant of the Aberdeen Shipbuilding Company, Aberdeen, Wash.

cessful in getting out of the way, and the result was a lame shoulder for a few days.

I am not entirely familiar with all of the routine by which men formerly became riveters, but I feel sure that this new system by which there is always an instructor ready to tell each apprentice the right thing at the right time, is such a wonderful improvement that companies will never go back to any of the old systems again.

Now that I am a regular member of the yard force, I do not of course know what the future has in store for me. I firmly believe, however, that every trade has its own opportunities, and that the field before me is just as broad as if I were still a school teacher. In fact, my present ambition is to become a riveting instructor, because I can now appreciate more than most men the wonderful work that can be accomplished by such a corps of practical trade instructors.

CHAPTER XII

FUTURE OPPORTUNITIES FOR EMPLOYMENT IN AMERICAN SHIPBUILDING

IT is scarcely possible to make any general statements as to the type of training, experience, or physical and mental qualifications which are most likely to be in demand. In an industry offering occupations of so many different kinds, this question can only be answered as it has been in the various sections of this book; that is, by a discussion of the requirements in each trade. It may be said, however, that shipbuilding will continue to draw men from the following groups:

1. Those who have been trained in colleges or technical institutions will be needed for executive positions, for both hull and engineering drafting, and for positions in various office departments.
2. Young men without previous experience or special training will be wanted to learn any of the trades or to enter any of the departments as beginners.
3. Experienced men from trades somewhat similar to those found in the shipyards will be able to find profitable employment in shipbuilding.

Opportunities for men in the first two groups have been fully discussed, especially in chapters V, VI, VII, and IX.

Although the relative number to be drawn from the second group will probably increase after the present crisis is over, there will always be some demand for skilled mechanics from the outside trades. For them shipyard work has appealed on a patriotic basis, and high wages

have formed an added inducement where loyalty alone failed to secure the required numbers. Even in peace times, the shipyard experience is likely to prove very valuable to men engaged in wood or steel construction, in pattern-making, coppersmithing, electrical work, and similar trades as well as for the mechanical engineer. The fact that such men come in close contact with a great many other interesting lines of work, coupled with the lack of monotonous duplication in most shipyard construction, gives such men a wider knowledge and training than they could get elsewhere.

The following statement from Mr. Charles C. West, Superintending Constructor for the United States Navy at the Ford Motor Company in Detroit, expresses a similar point of view:

> In my opinion American shipbuilding not only offers exceptional opportunities to young men in the way of pecuniary remuneration, but the business itself includes such a wide range of engineering activity that the modern shipbuilder can readily go into other lines if he so desires after the war is over. The tremendous construction of tonnage in this country has permitted shipbuilders to make expenditures for plants and to adopt methods of construction which were not possible when the business was on a hand-to-mouth pre-war basis. Orders for a large number of duplicate ships have enabled shipbuilders to adopt manufacturing methods and develop such comparatively new methods as multiple punching, electric welding, and assembly construction in a manner never before dreamed of. This development has only started and the young man going into the shipbuilding business now comes in at a time when progress is most rapid and new things are being constantly evolved.

Although the accompanying list (pages 257–259) is not complete, it offers suggestions as to the kinds of work

which skilled mechanics can be expected to undertake. Classes have now been organized in nearly all of the shipyards which enable skilled men to get very quickly the additional knowledge or skill necessary in undertaking the new trades.

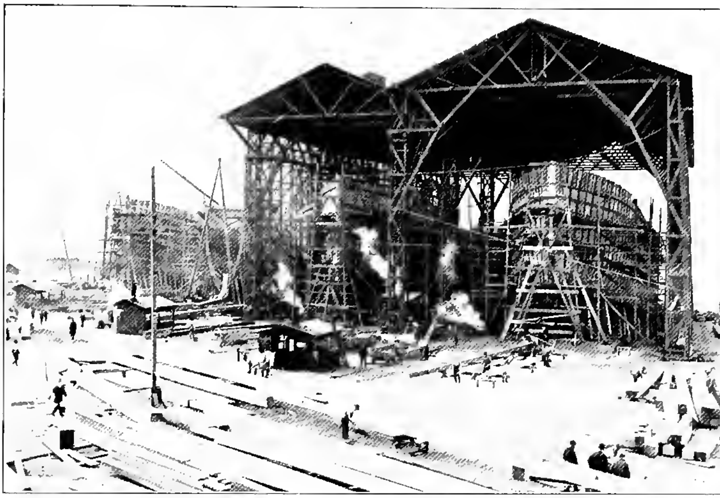
A correspondent of the "London Daily Chronicle" has the following to say regarding the work women are doing in the shipyards and marine engineering shops in Great Britain:

I have before me a carefully compiled record of the multifarious jobs being done, and well, by women in and about shipyards and marine engineering shops. Before setting them down I will quote the words of an eminent Scottish shipyard expert: "Strength and endurance alone prevent women from doing all the jobs. They are intelligent enough — more intelligent than many of the men; they work hard; they don't get 'fed up' with doing the same job constantly. Give them a repetition job that makes good pay and they will go on with it week after week — quite happily. But there are jobs they cannot do: heavy riveting; working up to their knees in water and mud, repairing the keel of a ship, moving material about the yards, and so on."

On board ship, women are fitting electrical apparatus for yard lighting, mains, and telephones, and doing complex wiring work generally. They are also chipping, scraping, and painting. In the yards they are hydraulic riveting, scraping, and coating the bottoms of destroyers and submarines, driving cranes, doing French polishing, loading into wagons and barges, and cleaning and painting chain cables.

In the workshops in or near the yards they make and repair the overalls and "Fearnought" clothing, make flags and sails, and do upholstery. Many had thought that wood-working machinery ran at too high a speed for women, but women are operating machines for wood planing and for making wooden boiler tube plugs.

In the engineering shops we find them at work on six-inch



WOODEN HULLS UNDER CONSTRUCTION ON THE PACIFIC COAST

Launchings of wooden ships for the first five months of 1918 equaled those for the whole of 1917. In addition to government contracts, Norway has placed orders for 100 wooden motor ships to be built on the Pacific Coast

LAUNCHING A WOODEN SHIP ON THE MAINE COAST

Years ago our American yards were famous for their clipper ships. A great revival of this industry in the East and the South has accompanied its rapid expansion on the Pacific Slop

A SUMMARY OF SHIPBUILDING AND KINDRED TRADES

[Prepared by Kenneth G. Smith for the Federal Board for Vocational Education]

Trades outside of shipyards	*Shipyard trades in which these craftsmen may be used*
Architectural iron worker	Anglesmith.
Asbestos workers	Pipe-coverers.
Auto repair man	Ship-fitter. Outside machinist.
Blacksmiths: Railroad blacksmiths Machine blacksmiths Hammer men Tool-dressers	Blacksmith. Hammer men. Tool-dressers. Shipsmiths. Anglesmiths. Plate and shape furnace men. Ship-fitters.
Boiler-maker	Boiler-maker. Ship-fitter. Flange-turner.
Bricklayer	Pipe-coverer. Cementer. Bricklayer.
Bucker-up. (*See* Riveter.)	
Cabinet-maker	Joiner. Template-maker.
Carpenter	Ship carpenter (shipwright). Ship-joiner (if he has had experience on inside work.) Mold loftsman. Ship-fitter.
Carvers	Carving (in joiner shop.)
Carriagesmith Wagonsmith Wheelwright	Blacksmith. Anglesmith. Plate and shape furnace man. Ship-fitter.
Chipper	Chipper (in foundry). Chipper (in yard and on ship). Calker (steel). Riveter.
Concrete man	Cementer. Pipe-coverer.
Core-maker	Core-maker.
Coppersmith	Coppersmith.
Dock-builders	Ship carpenters (stage-builders).
Drop forger	Drop forger.
Engineers, steam	Outside machinists (if they have had erecting or repair experience). Pipe-fitters.

A SUMMARY OF SHIPBUILDING AND KINDRED TRADES
(continued)

Trades outside of shipyards	*Shipyard trades in which these craftsmen may be used*
Erecting engineer or road man....	Outside machinist. Shipwright.
Elevator constructor.............	Outside machinist. Shipwright.
Electrical workers:	
(*a*) Outside man...............	Outside wireman in yard.
(*b*) Inside wireman.............	Wireman on ship.
(*c*) Telephone installer......... (*d*) Wire chief................. (*e*) Trouble shooter............ (*f*) Switchboard man...........	Wiring on intercommunicating systems.
(*g*) Motor repair man...........	Motor repairer and installer.
(*h*) Armature winder...........	Armature winder.
Galvanizer.......................	Galvanizer.
Gas-fitter. (*See* Pipe-fitter.)	
Granite cutters.................. Stone cutters.................. Quarrymen.....................	Chipper and calkers. Drillers and reamers.
Heater. (*See* Riveter.)	
Horseshoers......................	Blacksmith. Anglesmith. Plate and shape furnace man (or helpers). Ship-fitter.
House-mover.....................	Shipwright.
Lumber-jacks....................	Ship carpenters. Lumber handlers and stage-builders.
Machinists.......................	Floor hands. Bench hands. Machine hands. Machine operators. Outside machinists.
Molders.........................	Molders of all kinds. Green sand, dry sand, bench, side floor and floor, cast iron, steels, and brass.
Ornamental iron-worker..........	Anglesmith.
Painter..........................	Painter.
Pipe-fitters:	
Steam-fitter................... Gas-fitter.....................	Pipe-fitters.
Pile-driver man..................	Shipwright.

A SUMMARY OF SHIPBUILDING AND KINDRED TRADES
(continued)

Trades outside of shipyards	*Shipyard trades in which these craftsmen may be used*
Plumbers	Plumbers.
Painters	Painters (wood and metal).
Passer. (*See* Riveter.)	
Plasterers	Pipe-coverers, cementers.
Quarrymen. (*See* Granite-cutters.)	
Riggers	Yard-riggers. Bolter-up.
Riveters:	
Structural Tank Automobile	Riveters.
Bucker-ups	Holder-ons.
Passers, heaters	Passers, heaters.
Sailors	Rigger (in rigging loft).
Steam-fitter. (*See* Pipe-fitter.)	
Structural iron-workers:	
(*a*) Structural marker	Ship-fitter. Loftsman.
(*b*) Structural fitter	Assembler or bolter-up. Ship-fitter. Loftsman.
(*c*) Structural liner or regulator	Shipwright. Assembler. Ship-fitter.
(*d*) Structural erector	Assembler or bolter-up. Ship-fitter. Shipwright. Riveter.
(*e*) Structural template-maker	Template-maker. Loftsman.
(*f*) Structural draftsman	Draftsman. Mold loftsman. Ship-fitter.
(*g*) Structural yard man	Material man. Cold sawyer. Yard man.
Sheet-metal worker	Sheet-metal worker. Ship-fitter. Mold loftsman.
Tent and awning maker.	Sailmaker.
Wagonsmith. (*See* Carriagesmith.)	
Wheelwright. (*See* Carriagesmith.)	Joiner shop or carpenter.
Wood-finisher	Wood-finisher.

and eight-inch slotting machines, horizontal and vertical drilling machines, and turret and capstan lathes (non-repetition work in very many cases, the women setting up their own tools). One woman, said to be able to turn her hand to any job, operates a radial turret drilling machine with capstan head which performs six operations. Overhead cranes are driven by women, and one woman drives a traveling jib crane among the small lathes. They are generally employed on radial and sensitive drills and milling machines, and turbine blades are made and assembled by them. Women are also acetylene welding, nut facing, and acting as plumbers' assistants. In the foundries they are machine molding, core-making, grinding, packing, and sorting.

The boiler shops find them at work drilling, boring, slotting, helping on light planers, painting, assisting with rivet machines, pickling boiler tubes, cutting tubes, removing burrs from tubes and plugging them, and turning tube expander mandrils. They are fitting and filing pipe and valve flanges, filters, and valves, and bending superheater tubes. They are constantly working in the rigging loft on wire ropes of one and one half inches, and have done two inches. In the braziers' shops they are repairing lamps and soldering.

Of the more readily suitable jobs, such as tracing, store-keeping, time-clerking, scutching and spinning fiber in rope shops, looking after switchboards in generating stations, and lacquering, there are a great number.

All these are not jobs ideally suited to women. That the women are doing them, and, on the whole, well, is sufficient tribute to their fearless adventuring on any task open to them, to their inspiring industry, and to their great and whole-hearted championship of the cause of humanity — the Allied cause.

In the United States, women have not yet been called upon to undertake shipyard work to any great extent. It has been traditional for men to be employed even in the clerical duties of the shipbuilding offices. In all of the newer yards and in the larger plants, it has, of course,

been necessary to bring women into the offices, but very few have been employed so far for other tasks. If the war continues to reduce our supply of men, it is quite possible that women in greater numbers will be called upon to assume these duties. Conditions in some of the shops are favorable to their working in them, but hull construction presents many grave difficulties. Much of the work involves heavy lifting, climbing about upon scaffolding, and constant exposure to the weather.

In any event, more and more women will be needed for clerical and stenographic work and possibly some of the lighter work of the shops and some of the tracing, drafting, and blue-printing will be done by them. If the emergency demands their service in the more difficult shipbuilding trades, American women will no doubt respond as loyally as those of Great Britain, but it is to be hoped that this sacrifice will not be necessary.

Several questions regarding the future of opportunities in shipbuilding will naturally be raised by trained men who are seeking new vocational openings and by young men who are trying to decide upon a suitable life-calling. The most important of these questions will deal with the probable future development of the industry and with the chance for personal advancement as soon as promotion is merited. Such questions are almost impossible to answer in a satisfactory manner as long as the war continues. Among the various sources of information, none are more reliable than the heads of shipbuilding and navigation companies. These men are in close touch with the whole situation and are in a position to know as much as any one about the changes which may reasonably be expected to take place after the war is over. That their statements are not too optimistic, is demonstrated by the

general attitude of the Government and of large financial interests. Furthermore, these men are in no position to profit by bringing about an overcrowded employment condition in the shipbuilding trades. Their interests, as well as those of the country at large, are best served by securing no more than an adequate supply of competent workmen. While the war lasts, there can be no question as to the demand for men, nor of the obligation upon any one now employed in non-essential work to enter the industry if he is properly qualified and the opportunity is offered.

All of the statements which follow were prepared for this volume at the request of the Harvard Bureau of Vocational Guidance with the understanding that they were to be used in acquainting the public with employment conditions in the shipyards.

Mr. B. L. Worden, General Manager, Submarine Boat Corporation, Newark, New Jersey:

Relative to the opportunities that now exist in shipbuilding for men who have the desire to advance, I would say that it is a rule which seldom fails that a virgin field in industry offers the best opportunities for advancement.

Unquestionably, shipbuilding in this country, at the present time, represents such a field. From a country which, previous to a year ago, had relatively few shipyards, we have immediately advanced to the largest shipbuilding nation in the world; this from a standpoint of organization for the job, with a minor portion of the actual work, for which we have organized, already completed.

One of the greatest problems that the shipbuilder has had to deal with is that of providing adequate labor, both from the standpoint of quantity and quality. While quantity may be provided, quality must develop. In the development of quality, a weeding-out process must occur. As a result of such a weeding-out process, those workers who have quality predom-

inant in their make-up must advance and from such men our future foremen and superintendents will be drawn.

With the present plans in effect for intensive training and for the education of workers in shipyards, there should result a higher grade of supervision in the future. Unquestionably there never has existed, in previous times, such an opportunity for trained or untrained men, particularly untrained, to enter an industry and obtain high skill and high wages in so short a time, with unlimited opportunity for advancement, as there is now in the shipbuilding industry and as will exist in the immediate future.

Mr. S. W. Wakeman, General Manager, Fore River Plant, Bethlehem Shipbuilding Corporation, Limited, Quincy, Massachusetts:

Shipbuilding before the war was an occupation which was being carried on by a very few people who were concerned chiefly with the building of naval vessels. Owing to the attitude of our Government, the American Merchant Marine had practically disappeared and the opportunities for men to go into shipbuilding work were very limited. The declaration of war, however, changed this entire situation and the shipbuilders who had found difficulty in operating their plants because of the lack of contracts were deluged with contracts and were immediately confronted with the difficulty of getting labor to handle these contracts.

There is no business in the United States to-day which offers a greater field for technically trained mechanics and for men of ambition than does the shipbuilding business. Of its nature, it is necessarily complicated and takes considerable time and effort to get a thorough understanding of its peculiarities. However, if a young man is willing to work intelligently and is at the same time willing to make reasonable progress, and does not expect to accomplish more than should be expected in a given time, he can go a long distance in any of the shipyards in this country.

Our great difficulty at present is to find leading men, quartermen, assistant foremen, and foremen. As the existing plants

expand and take on more work, this problem becomes a very serious one. The opportunities to-day in a shipyard do not consist of going into a plant and wearing a white collar and sitting down at a desk with the idea of some time becoming a master shipbuilder. It is necessary for a man to go out in the yard and start in doing the actual work of building ships. If a young man will do this, at the end of eight or ten years of hard, conscientious work he should arrive at a position which will be entirely satisfactory from his point of view.

Mr. J. W. Powell, Vice-President, Bethlehem Shipbuilding Corporation, Limited, Bethlehem, Pennsylvania:

There is no other industry in America which offers the unusual opportunities now offered by shipbuilding to men of all trades.

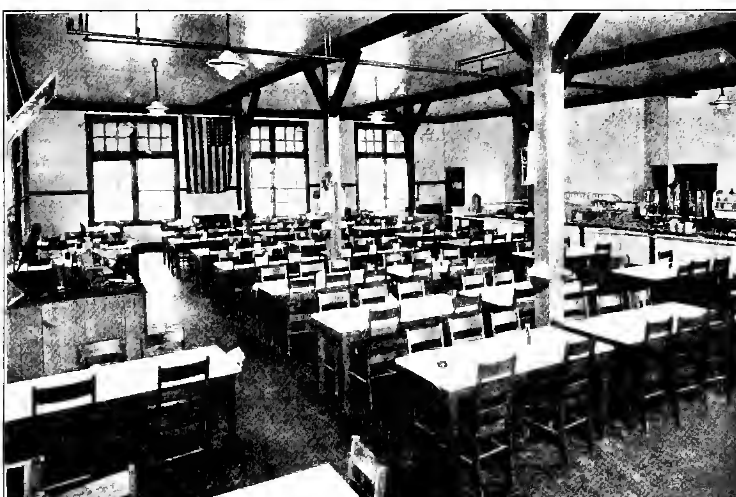
The rapid expansion of this industry in this country during the past two years has created unprecedented demands for skilled artisans, and as shipbuilding employs numerous trades, in fact almost every trade, the opportunity is unusual for men to enter this rapidly growing field and quickly forge ahead to responsible positions.

The increase in the shipbuilding activities of this country during the past four years, and particularly since we entered the war, has been so rapid that the supply of trained shipyard workers was soon exhausted. Each new yard which sprang into existence called trained men away from the old established yards, promoting many of them to foremen, superintendents, etc., so that yards all over the country were forced to establish a method of quickly training green hands into shipbuilders. The older experienced men were advanced to leading positions, and schools were started to rapidly teach the new men shipyard trades. Old methods were abandoned and new methods of specialization adopted, so that in a remarkably short time a green man is now developed into an acceptably efficient shipworker.

Shipyards which in 1914 employed between 4000 and 5000 men are now employing between 10,000 and 15,000, and the crying need is for responsible leaders, so that any mechanic, who shows aggressiveness and ability, may be sure he is being watched against the day when he is ready to be advanced to a

THE GENERAL SAFETY COMMITTEE OF A LARGE SHIPBUILDING CONCERN

The Safety Engineering Section of the Emergency Fleet Corporation coöperates with the yards in reducing accidents. Committees consisting of workmen and department heads in each plant examine into the causes for injuries and try to reduce the hazards



A CORNER OF THE EMPLOYEES' DINING-ROOM, SUBMARINE BOAT CORPORATION, NEWARK, N. J., MAY, 1918

leading position, and any bright American entering a shipyard can hope for rapid advancement, if he shows the right stuff, although he may never have seen a ship before in his life.

Naturally the first question asked by any man in an outside trade, is in regard to the permanency of shipyard employment. A great army is now engaged in shipbuilding. Shipyards have come into existence wherever the natural surroundings permit the construction of seagoing vessels, and the Government, as well as private interests, have made large outlays of capital to finance the present shipbuilding programme; therefore, it seems only reasonable to assume that the influence of this vast army of workers engaged in this industry, together with the financial interests all over the country, will exert a powerful pressure upon future legislation. When the intense activities of the present war cease, laws will be made placing the American shipbuilding industry and the American Merchant Marine on such a footing that it is fair to hope they will be able to compete with all foreign interests.

Moreover, millions of tons of shipping have been destroyed in this war, and these millions of tons must be replaced, offering steady business to the American shipyards, to keep them moving at full speed for at least some years to come.

To sum up the whole situation, the shipbuilding industry to-day offers men in almost every trade, permanent, well-paid work, under excellent conditions, and with good opportunity for advancement. There is ample opportunity for an untrained man to receive a schooling in any trade, and rapidly make himself an expert artisan which will fit him for high class employment. Almost any able-bodied man can render his country valuable patriotic service by going into a shipyard, as ships are the key-note to our successful prosecution of the war.

Mr. B. W. Morse, Vice-President and General Manager, Virginia Shipbuilding Corporation, Alexandria, Virginia, and General Manager of the United States Steamship Company:

Shipbuilding after the war is an open question and one of moment. It is not a local question nor yet solely a national

question. As the shipping industry touches the world's confines, so shipbuilding in any major nation is affected by world conditions in that industry. It is not a "war bride" industry which will shrink to minor importance after the war. Readjustment to peace conditions will eliminate certain industries, curtail others and reëstablish still others that have lain dormant. Shipbuilding will never go back to pre-war normal. However, the yards will cease their frantic day and night rush; labor forces will be cut down to a peace basis; temporary yards will be abandoned; and the wood-shipbuilding branches will no doubt be curtailed to the extent that they will be utilized only for supplying tonnage in a limited trade. But when this war is over, ships will have played their part in saving our nation, and the need for carriers will never again go unheeded.

America, with respect to the rest of the world, has been a suburban nation and we a race of commuters, transporting our persons and our goods over alien-owned carriers. As commuters we have given to the carriers a priceless franchise we might have exercised to our own profit. The great number of ships we will have under the American flag after the war, will bring about a sorely needed change in our legislation, relative to the operation of ships and the expenses going into ship-construction. With wise legislation we shall bring about such conditions in building and operation as will enable us to compete successfully with foreign shipyards and foreign-owned shipping, and such conditions, together with the start the United States has obtained in volume or tonnage brought about through war exigencies, will enable it to maintain after the war the position which it has established during the war as the leading maritime nation. But without such wise and favorable legislation for ship-construction and operation, the future of American shipping, after the needs created by the war have been filled, is a serious question.

The scope of the industry will be fixed by the inexorable law of supply and demand. How many ships have we now? what is the per annum capacity of our permanent yards? what toll will the Hun take? These are the prime factors affecting our supply. According to the United States Shipping Board, we now have more than eight million tons of shipping under Gov-

ernment control, including tonnage in the coastwise and Great Lakes trade. Before the war our total was less than two and one half million tons. We have to-day, under contract and constructed, more than eight hundred shipways — twice as many as there are in all the rest of the shipyards of the world combined. At the present rate of progress in these yards we expect to have a merchant marine aggregating twenty-five million tons by the end of the year 1920. As for the menace of the U-boat, the Hun's ruthless warfare has been overreached, his submersibles are being sunk faster than he can build them and the Allied sea patrols are changing the rôle of these murderous craft from hunter to hunted. We will continue to lose some ships, but not a sufficient number to materially affect the total supply.

Thus the supply: what of the demand? There will be a demand for ships to carry our raw materials to rebuild devastated Europe; likewise to carry our manufactures to nations whose factories have been destroyed, their organizations swept away, and their capital squandered in war. If we can count upon a change in our legislative policy which will remove the inimical laws that for the past thirty years have throttled our merchant marine, we can meet this demand. And before Europe is rehabilitated we will have reached first place in the markets of the world, and America's vast storehouse, heretofore practically untouched, will be opened wide to the possibilities of trade. All this will demand ships — more ships than we have ever needed before.

Not only shall we have increased activity along established trade routes, but new trade routes will be established. South American trade will become a most profitable fact, instead of a vague theory. The west coast of that southern neighbor, via the Panama Canal, as well as Brazil and Argentina on the east, will be joined to our shores with marine arteries. What share have we had of the Asiatic trade; what access to the markets of China, Japan, Siberian Russia, and India? Ships will give us our share of this trade. As American owned lines are established, the trade will follow the flag, until shipbuilding for our ever-increasing merchant fleet will keep the rivets hot in a hundred yards. Briefly then: We have always had vast sup-

plies of raw materials; we have always had vast potentialities in manufactured products; and now we have the ships to carry them. These ships will capture our share of established trade; they will reopen old lines and establish new lines; and since there is no doubt that American bottoms will increase American trade (unless hampered by shortsighted legislation) there can be no doubt that the increased trade will mean more ships.

Passenger lines are going to be in demand. This war has driven us into shipbuilding and we have now so mastered that industry that our passenger ships will never be built abroad.

It is well to remember in passing that two and one half million tons of our present fleet represents commandeered vessels of foreign powers, which will have to be replaced by American shipyards after this war.

One of the changes in shipbuilding after the war will be the greater standardization of ships. Certain yards will devote themselves to the manufacture of certain types of ships and these ships will be standardized and put out. Then when ships are lost by operating companies, other ships will be ready for them to put into the trade, or as their business grows they can have other ships always available to take care of their increase, instead of having to wait a year or more to have a ship built after it is ordered.

What of our Navy? The lesson of preparedness, coming late, has been thoroughly learned. We must for a time maintain a gigantic navy. America, all unconsciously, is being thrust into the position of arbiter for the world. In world politics we must maintain and exercise the balance of power. As the United States is the stanchest supporter of the Hague Tribunal and its policy of arbitration of international disputes, so the surest guarantee of universal peace is unquestioned power behind American policies. There is a proposal to establish an economic league of nations after the war. It will undoubtedly become a fact. But the navies of the world are not destined to be discarded soon because of such a league of peace. While confidently awaiting the day when international disputes will be settled by peaceful methods instead of the power of armaments, yet there will be a period of years to

come during which the best insurance for our merchant marine fleet is a wholesome respect for the power behind the Stars and Stripes at each masthead. To fill this high purpose our Navy will continue to need ships, many ships.

It is difficult to gauge the spirit of this nation or the heights to which an aroused national consciousness can carry it. Not only the German war lords, but we ourselves have been astonished at our tremendous strides in shipbuilding. Lacking shipyards or trained men to fill them, we have built the yards and trained the men, and already the work of these yards surpasses all hopes. New world records have been established in the completion of the plants and we are lowering records in the building of the ships every week. Uncle Sam has become the master shipbuilder and it is conceivable that, after the war, a large proportion of foreign shipping will come to these shores for building. Shipbuilding after the war will rank among the greatest of our industries. It offers a future which is attracting some of our ablest, most ambitious and truest citizens, for in its pursuit we raise bulwarks for America and we serve the world.

Mr. Simon Lake, President of the Housatonic Shipbuilding Company, Stratford, Connecticut:

Now that the United States has been forced to go into shipbuilding on a large scale to preserve to the liberty-loving people of the world the right to elect their own governing bodies, we as a Nation are likely to again take an important place in shipbuilding which since the Civil War has been dominated by foreign nations.

This is a great opportunity for young Americans with constructive or operative ability to learn a business which formerly added much to the prestige of America, as our merchant marine in former days carried our own products under our own flag to every port in the world. Now is our opportunity to restore our lost prestige, and the fact that we have entered this great war for the purpose of benefiting our suffering brothers of other nationalities makes it incumbent upon us to keep our flag flying from the topmast of numerous ships in every port of the world as an emblem that "Liberty has not perished from the earth."

The forecast of future developments in this industry expressed in the above quotations is emphasized by statements made by the Chairman of the United States Shipping Board, Mr. Edward N. Hurley. He writes as follows for the anniversary number of one of the shipyard publications:

A good many people assume that when peace comes again and the war needs for ships have been met, the 160 new shipyards which have been created under the United States Shipping Board Emergency Fleet Corporation will have nothing to do. That is a mistaken assumption. We are not anywhere near the end of this shipbuilding job — we are only beginning. Think of the 25,000,000 tons of merchant ships which are being built under the present programme. That represents something like 3000 vessels, most of them modern steel steamers.

We are remodeling our ports and preparing to run our ocean fleet as we run our railroads — with the lowest freight and passenger rates in the world and the best service and a reasonable profit for people who put their money into them. Several hundred thousand young Americans are going to sea as officers and sailors in this merchant marine. Millions of dollars of American capital are going to be invested in foreign countries to develop their resources and create export and import trade.

The thought of America is now turning to merchant ships and foreign lands as never before. We are not merely going to revive our Yankee clipper ships — we are going to beat them.

To the shipworker this can mean only one thing — that for years after peace comes our ships will be busy and our shipyards, too. We shall build more and more tonnage for ourselves and other nations, and we shall be busy repairing and remodeling ships. If I were to review the past year in American shipbuilding I should merely repeat the story of an industry of 45,000 workers increased to 350,000 in the shipyards and 250,000 more back in the factories, making ship-boilers and engines and equipment. It is far more inspiring to look ahead and see what this industry is to become in five years. To-day our railroads employ one million men. I venture to predict that

within five years more than one million men will be employed in connection with the American merchant marine — the workers in shipyards, the officers and seamen who man our ships, the men and women in factories making ship equipment and the army of people engaged in export trade.

The motives which lie back of the present efforts of the Shipping Board and which will continue to actuate the American people in developing our merchant marine have naturally been questioned by friends of Germany. Every doubt or unreasonable question of this kind has been faced and answered by Government officials. The Shipping Board has authorized the following statement through its Chairman, Mr. Hurley:

President Wilson has demonstrated to the world that the people of the United States are not fighting for the permanency of their own liberty alone, but for the liberty of civilization everywhere.

It is unthinkable that a nation fighting shoulder to shoulder with other great democracies should, after the war, turn its resources against them for trade conquests of the very kind which were largely instrumental in bringing on the war. If our ships do not bring prosperity to our neighbors as well as to ourselves, our own pride in the achievement will be diminished. Our ships will be operated after the war upon principles which recognize human and national rights and equities. This is a part of the consistent policy of President Wilson. It is made plain in his public statements. It is also plain in the history of the United States, which is free from selfish aggression in either territory or trade.

In building her merchant fleet America plans first of all to win the war, and after that to overcome her own neglect in providing ocean transportation for her own trade. To this end the people of the United States are preparing to develop transportation on their own trade routes, without disturbing the trade or rights of other nations. And they, furthermore, hope that the American merchant marine will play a large part in

bringing the neighboring democracies of the American hemisphere closer together.

Suggestions of selfish motives will, of course, be circulated in connection with the fleet we are building. Every nation lined up against autocracy can be depended upon to detect the source of such suggestions, and discount them, and maintain the solid line for democracy and humanity till the end.

APPENDIX

BIBLIOGRAPHY

GLOSSARY OF TERMS

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APPENDIX

A

MINIMUM WAGE SCALES IN CERTAIN SHIPBUILDING TRADES

THE Shipbuilding Labor Adjustment Board was organized on the basis of an agreement between the Navy Department, the Emergency Fleet Corporation, and the international presidents of the principal unions concerned with the shipbuilding industry, entered into August 20, 1917, and revised December 8, 1917. The parties to the agreement clothed the Board with power to regulate wages, hours, and working conditions in shipyards having direct contracts from the Navy Department and the Emergency Fleet Corporation.

The Board has established wages and regulations in reference to hours, compensation for overtime, etc., for all the shipyards of the country, since practically all of them are now doing work only for these two departments of the Government. These regulations are subject to revision after six months, providing that a general and material increase in the cost of living can be shown to have occurred.

The members of the Board are: V. Everit Macy, Chairman, appointed by the President; L. C. Marshall, appointed by the Navy Department and the Emergency Fleet Corporation to represent the Government; and A. J. Berres, appointed by the American Federation of Labor to represent organized labor.

The wage scale given below is practically the same as that in effect for the shipyards along the Great Lakes and for those of the South Atlantic and Gulf Coast, and applies in most particulars to those located along the Delaware River and near Baltimore. Conditions on the Pacific Coast are somewhat different, and the scale for that region is given in full.

It should be understood that these wage scales represent the minimum amounts paid. Where workmen are paid at piece-rates, many are able to command very much higher wages than these scales would indicate.

APPENDIX

MINIMUM WAGE SCALE

For Journeymen, Specialists, Helpers, and Laborers in Specified Crafts in the North Atlantic and Hudson River Steel Shipyards

April 6, 1918

	Rate per hour
Acetylene Department	
Burners, 1st class	$ .65
Burners, 2d class	.60
Grinders	.50
Chippers	.50
Welders	.65
Helpers	.46
Anglesmith Department	
Anglesmiths, heavy fires	.87½
Anglesmiths, heavy fires, helpers	.55
Anglesmiths, other fires	.72½
Anglesmiths, other fires, helpers	.46
Furnace men on shapes and plates (shipwork)	.82½
Electric welder	.65
Blacksmith Shop	
Hammer and machine forgers, heavy	1.35
Heater	.55
Lever men or crane men	.70
Helpers	.50
Hammer runners, heavy	.55
Blacksmiths, heavy fires	.87½
Blacksmiths, heavy fires, helpers	.55
Blacksmiths, other fires	.72½
Blacksmiths, other fires, helpers	.46
Drop forgers	.70
Drop forgers, helpers	.50
Boltmakers	.72½
Boltmakers, helpers	.46
Laborers	.40
Liner forgers	.55
Liner forgers, helpers	.46

	Rate per hour
Boiler Shop	
Boiler-makers	$.70
Drillers	.60
Holders-on	.50
Rivet-heaters	.40
Flange-turners	.75
Helpers	.46
Slab furnace men	.75
Planer hands	.55
Bolting and Liner Department	
Bolters	.50
Liner men	.54
Helpers	.42½
Cement Department	
Cementers	.50
Helpers	.42½
Chipping and Calking Department	
Tank-testers	.80
Chippers and calkers	.70
Packers	.50
Cleaning Department	
Leader	.55
Laborers	.40
Coppersmith Department	
Coppersmiths	.72½
Plumbers and pipe-fitters	.72½
Helpers	.46
Drilling and Reaming Department	
Drillers	.60
Reamers	.50
Electrical Department	
Electricians, 1st class	.70
Electricians, 2d class	.65

	Rate per hour
Electrical Department	
Wiremen	$ .55
Joiners	.70
Machinists, 1st class	.72½
Helpers	.46
Erecting Department	
Leading men	.85
Marine erectors, 1st class	.72½
Marine erectors, 2d class	.62½
Specialists or handy men	.52
Helpers	.46
Fitting-up Department	
Fitters, 1st class	.72½
Fitters, 2d class	.65
Regulators, 1st class	.60
Regulators, 2d class	.52½
Helpers	.46
Foundry Department	
Molders	.72½
Cupola tenders	.72½
Helpers	.46
Hand and machine chippers	.50
Laborers	.40
Furnace Department	
Leaders	.67½
Firemen and helpers	.55
Strikers	.55
Hull Engineering Department	
Marine erectors, 1st class	.72½
Marine erectors, 2d class	.62½
Specialists or handy men	.52
Joiners	.70
Helpers	.46
Joiner Department	
Joiners	.70
Machine men	.70
Helpers	.42½
Lumber Department	
Machine men	.65
Helpers	.42½

	Rate per hour
Machine Shop	
Machinists, 1st class	$ .72½
Machinists, 2d class	.62½
Specialists or handy men	.52
Metal polishers, buffers and platers	.70
Helpers	.46
Material Labor Department.	
Engineers, locomotive	.65
Operators, locomotive, cantilever, gantry, and other cranes of over three tons	.70
Operators, stiff-legged derricks	.65
Hoisting and portable firemen	.50
Locomotive conductors	.50
Road crane conductors	.50
Mold Loft	
Gang leaders	.85
Loftsmen, 1st class	.82½
Loftsmen, 2d class	.72½
Joiners	.70
Helpers	.42½
Paint Department	
Painters and polishers	.60
Bitumastic painters	.72½
Helpers	.42½
Pattern-Shop	
Pattern-makers	.75
Laborers	.40
Rigging Department	
Marine leaders	.75
Marine riggers	.62½
Crane leaders	.75
Crane gang leaders	.67½
Crane men	.60
Erector leaders	.60
Erectors	.50
Riveting Department	
Rivet-testers	.80
Stage-builders	.57½

	Rate per hour
Riveting Department	
Riveters	$.70
Holders-on	.50
Heater boys	.38
Passer boys	.30
Helpers	.46
Ship Carpenter Department	
Ship carpenters, 1st class	.70
Ship carpenters, 2d class	.65
Helpers	.46
Ship Shed Department	
Punchers	.55
Planer and scarfer	.55
Countersinkers	.55
Drillers	.60
Bending rollers	.70

	Rate per hour
Ship Shed Department	
Mangle rollers	$.57½
Pressmen, 1st class	.62½
Pressmen, 2d class	.55
Offsetters	.55
Sawyers	.47½
Helpers	.46
Ventilation Department	
Sheet-metal workers	.73
Helpers	.46
All Departments	
Layers-out shall receive three cents an hour more than first-class journeymen in the same department.	
Laborers	.40

MINIMUM RATES FOR EMPLOYEES IN WOODEN SHIPYARDS IN ADDITION TO THOSE SPECIFIED FOR STEEL SHIPYARDS

	Rate per hour
Loftsmen, 1st class	$ .82½
Loftsmen, 2d class	.72½
Ship carpenters, 1st class	.70
Ship carpenters, 2d class	.65
Joiners	.70
Mill men	.70
Calkers	.70

	Rate per hour
Fasteners	$ .55
Reamers	.55
Offsetters	.55
Erectors	.55
Carpenters' helpers	.46
Laborers	.40
Oakum spinners (per bale)	2.25

APPENDIX

MINIMUM WAGE SCALE

For Journeymen, Specialists, Helpers, and Laborers in Specified Crafts in Shipyards of San Francisco Bay, Columbia River, and Puget Sound Districts Established by Board in Decision of November 4, 1917

	Rate per day		*Rate per day*
Machinists	$5.25	Riveters, chippers, and calkers	5.25
Machinists, specialists	4.00	Acetylene welders	5.25
Machinists, helpers	3.60	Plate-hangers	5.00
Molders	5.25	Punch and shear men	4.50
Pattern-makers	6.50	Planer men	4.20
Blacksmiths	5.25	Countersinkers	4.20
Blacksmiths, helpers	3.90	Drillers and reamers	4.20
Anglesmiths	5.25	Holders-on	4.20
Heaters	4.50	Slab helpers	3.90
Pipe-fitters	5.25	Plate-hangers, helpers	3.90
Pipe-fitters, helpers	3.60	Hook-tenders	3.90
Coppersmiths	6.00	Flange fire-helpers	3.90
Coppersmiths, helpers	3.90	Machine helpers, flange	3.90
Firemen	3.60	Boiler-makers, helpers	3.90
Sheet-metal workers	6.00	Ship-fitters, helpers	3.60
Sheet-metal workers, helpers	3.60	Rivet-heaters	3.15
Painters	5.00	Electrical workers	5.25
Painters, bitumastic	6.00	Electrical workers, helpers	3.60
Flange-turners	6.00	Molders, helpers	3.60
Angle and frame-setters	5.25	Foundry carpenters	4.50
Pressmen	5.25	Furnace men	4.50
Boiler-makers	5.25	Casting cleaners	3.90
Ship-fitters	5.25	Laborers	3.25

WOODEN SHIPYARDS

	Rate per day
Shipwrights, joiners, boat-builders, and mill men	$6.00
Calkers	6.50
Laborers and helpers	3.25

APPENDIX

SUPPLEMENTARY RATES ESTABLISHED BY EMERGENCY FLEET CORPORATION, DECEMBER 10, 1917

	Rate per day
Stationary and operating engineers	$5.25
Firemen, oilers, and water-tenders	3.60
Loftsmen	6.00
Rivet-heaters	3.60
Shipyard riggers	
Foremen	6.00
Journeymen	5.00
(San Francisco)	
Frost and asbestos workers	$5.25
Metal polishers and finishers	5.25
Bridge and structural iron workers	5.25
(Seattle)	
Storekeepers, watchmen, and janitors	3.60

SUPPLEMENTARY RATES ESTABLISHED BY EXAMINER HENRY MCBRIDE FOR PUGET SOUND DISTRICT, DECEMBER 14, 1917

	Rate per day
Engineers	
Locomotive cranes	$6.00
Gantry cranes	6.00
Double cable ways	6.00
All double machines	6.00
Electrical, steam or air operated winches and donkeys	6.00
Single Ariel cables, ways	5.50
Overhead cranes (in shops)	5.50
Steam and electrical operators in power houses	5.50
Engineers	
Engineers in charge of boilers	$5.00
Firemen with engineer in charge	4.00
Oilers	4.50
Furnace men	4.50
Single drum steam, electrical, or air winches and donkeys not hoisting	4.50

WOODEN SHIPYARDS, DECEMBER 22, 1917

	Rate per day
Fasteners	$4.50

To these rates ten per cent increase was added for all men who work for six consecutive days in any week, a total of not less than forty-eight hours, by order of Fleet Corporation on December 10, effective on and after December 15.

Eight hours constitute a day's work. Double time is allowed for all overtime.

B

OCCUPATIONS SIMILAR TO THE SHIPBUILDING TRADES

During the period of the war, it will continue to be necessary for the yards to employ people from outside occupations resembling the shipbuilding trades. In many cases only a short period of training will be required to enable the workman to perform the shipyard work successfully. Even after the present emergency has passed, it is likely that some modification of the methods of transfer and training now in use will still be extensively followed.

Probably the greatest demand at present is for strong, active men who are willing to do ordinary labor or act as helpers. A large proportion of the shipyard tasks require little or no special skill. Mechanics, particularly machinists and those engaged in the metal trades, can usually find opportunity for employment in any large steel yard.

Although the following list is not complete, it suggests the more important outside occupations from which persons may advantageously be transferred to shipyard work. Those who are engaged in any of the occupations listed below, provided their present work is not needed in carrying on the war, can profitably apply to the nearest office of the Federal Employment Service or to a near-by shipyard for employment.

The numbers refer to pages in the text which describe shipbuilding trades somewhat similar to the occupations listed in the table. See also the tables on pages 257, 258, and 259.

Trade	*Pages*
Accountant	209; 213
Acetylene cutter or welder	125; 163; 178
Anglesmith	125
Architect	104–111; 116–119
Architectural iron-worker	124–128
Asbestos-worker	196
Auto repair man	168; 172
Blacksmith	124–128; 164; 165; 225
Blue-print machine operator	111

APPENDIX

APPENDIX

BIBLIOGRAPHY

This list is intended to offer suggestions to the general reader or to the shipyard employee who desires to become better acquainted with the technical side of shipbuilding. The articles and books selected are for the most part of a general or descriptive nature, but a few of the standard textbooks on naval architecture, marine engineering, and ship construction and some of the best-known shipbuilders' manuals have been included.

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GLOSSARY OF TERMS

PREPARED BY BERT J. MORRIS

Harvard Bureau of Vocational Guidance

Aft. At or toward the rear of a ship.

After perpendicular. A vertical straight line at the aft edge of a rudder post.

Air hammer. A hammer driven by means of compressed air used in riveting.

Air holding-on hammer. Similar to an air hammer, used to hold against the head of a rivet while it is being driven.

Air pipes. Pipes leading from the double bottom to the upper deck to allow air to enter the tanks as the water ballast is being pumped out.

Air ports. Circular windows in the hull and the deck houses of a ship. They are sometimes called deadlights as heavy glass must be used to make them water-tight.

Anchor. A heavy iron or steel device which is fastened to a long chain or hawser and lowered to the bottom of the sea to prevent the ship from drifting when not under steam.

Anglesmith. A worker who has acquired special skill in bending, welding, and forming metals into angular shapes.

Annealing. To soften metal by heating and cooling it.

Athwartships. Across the ship, at right angles to the keel.

Ballast. Material of any kind — usually water — carried in the tanks or double bottom to steady a ship which does not have sufficient cargo to insure stability.

Barge. A freight boat towed by another vessel.

Base line. A horizontal line established for the purpose of reference in making vertical measurements.

Batten. A thin strip of wood, easily bent, used in fairing curved lines in the mold loft.

Below. A term which means below deck, corresponding to the phrase " down stairs."

Bending floor. The floor in the plate and angle shop on which plates and frames are bent.

Bending roll. A machine devised to bend piping or plates.

Bilge. The point at which the frames turn from the bottom to the

side of the ship. The term is also applied to the space between the shell plating and the double bottom of a ship.

Bilge keels. Projections fitted to the outside of the shell plating running along the bilge to prevent the ship from rolling.

Bitts. Steel castings fastened to the weather deck to hold mooring lines in place.

Boat chocks. Rests made of wood or iron on which the life boats are set.

Boat davits. Apparatus for the launching of life boats.

Body plan. An end view showing curves of the sides or frame lines at any point in the ship.

Bollard, or timberhead. The large iron or steel stake on the deck of a ship to which mooring lines are fastened.

Boom. A long heavy spar, pivoted at one end, used for loading and unloading cargo.

Boss. The curved portion of the ship's hull around the propeller shaft.

Bow. The front end of a ship.

Bridge. The platform running across the weather deck for the convenience of the officers in directing the course of the ship.

Bridge house. A house on the bridge platform used as living quarters for the officers of a ship.

Broadside. The ship's side above the water line from stem to stern.

Building slip. *See* Ways.

Bulb angle. An angle with one edge rounded.

Bulkhead. A partition corresponding to a wall in a building, running across a ship, or "fore and aft."

Bulwark. A protection wall or rail along the edge of the weatherdeck.

Bunker. The place where coal or other fuel is stored.

Buoyancy. The property by virtue of which the ship floats. It is the difference between the weight of the ship and the upward thrust of the water which the ship may displace.

Calking. To make water-tight.

Camber. The athwartship curvature of the deck. Sometimes it is spoken of as the "round-up" of the deck.

Cant frames. A group of frames extending over the rudder forming the stern of the ship.

Capstan. A mechanism revolving on a vertical axis, for hauling in ropes or chains. It is turned by hand or by steam.

Cargo. The freight carried by a ship.

Cargo battens. Strips of wood fastened inside of the frame in the hold to keep the cargo in place.

Cargo boom. The heavy boom used in handling cargo.

Cargo hatch. The opening through which the cargo is loaded and unloaded. Sometimes called "coaling hatch."

Center line. The middle line of the ship from stem to stern.

Chain locker. The place where the anchor chain is stowed.

Channel. A steel shape used as a stiffener or support.

Chart house. A small house on the bridge deck containing charts, navigation instruments, speaking tubes to engine room, and other apparatus for operating the ship.

Coast patrol. Ships placed on duty of guarding the ports of a country.

Compartment. A subdivision or room in a ship.

Condenser head. Connection at the top of a condenser.

Conduit. Pipe used to enclose electric wiring.

Countersink. To enlarge the upper part of a rivet hole.

Davits. *See* Boat davits. Also supports and hoisting gear for cargo.

Deadlight. *See* Air ports.

Deadweight. The total weight including passengers, crew, and cargo which a ship can carry.

Deck. That part of a ship that corresponds to the floor of a building.

Deck plan. A drawing or blue-print showing the plan of the deck.

Derrick post. A mast or fixed post upon which swings a derrick for hoisting heavy weights.

Die. A tool for forming a rivet head. A flush die flattens the rivet into a countersunk hole; a snap die forms a round head.

Displacement. The weight of the volume of water which a ship displaces, or the total weight of the ship and everything on board.

Dog. A small metal clamp used for fastening doors, hatch covers, and manhole covers. Also used in the plate and angle shop for holding bars in place for bending.

Dolly bar. Heavy bar to hold against a rivet.

Double bottom. This is the space between the outer bottom or keel of the ship and the inner bottom or lowest deck. The space is divided into compartments by *floors* or vertical plates of steel, extending from the outer to the inner bottom. These compartments, known as tanks, are used for carrying fuel oil, or water ballast.

Draft. The depth in the water of the lowest part of the ship when the ship is in motion.

Draftsman. The draftsman makes blue-prints of the designs worked out by the architect showing in detail all the numerous parts and equipment of the ship.

Dreadnaught. A war ship of immense size, strength, and speed.

Fabricate. To punch, cut, shear, drill, bend, weld, or flange plates and shapes.

Fabricated ship. A ship on which the work of cutting, drilling, bending, welding, and shaping the plates is done in a standardized steel construction factory.

Fair. In proper position, square.

Flange. To bend plates to form an angle. Also a raised or projecting rim.

Floor. A floor is a solid plate extending from the center to the bilge of the ship and from the outer to the inner bottom. Floors divide the double bottom into watertight compartments.

Fluke. The hook or part of the anchor which catches upon the ocean bed and keeps the ship from moving.

Flush rivet. A rivet with the head countersunk on one or both sides and riveted even with the plate or nearly so.

Fore. At or toward the front of a ship.

Fore and aft. In a longitudinal direction with the length of a ship.

Frames. Steel sections which form the ribs of the ship.

Free board. The distance, measured at the middle of the ship, from the main deck to the water line when the ship is loaded.

Galley. The part of the ship that corresponds to a kitchen in a house.

Gangways. Passageways through the *bulwarks* of a ship. Sometimes the term gangway is used of a ladder or other contrivance by which persons board a ship.

Grab stand. A tool for holding a drill which can be fastened to the edge of a plate or angle.

Hatch. An opening in the deck of a ship.

Hawser. A large rope.

Hawse pipe. Hole through which mooring cable runs.

Hold. The lower part of a ship, usually below the water line, where the cargo is stowed.

Hull. The body of the ship.

Hunnewell hull. A hull with the middle part made of steel and curving portions of the bow and stern made of concrete. The name is derived from that of the inventor, Naval Constructor F. A. Hunnewell.

Inboard. Toward the center line of the ship.

Inner bottom. The upper boundary of the double bottom of the ship. Tank top is another name for it.

Intercostals. Short plates between frames.

Jam hammer. A holding-on hammer which strikes a blow; used in heavy riveting.

Keel. The chief and lowest timber or plate of a ship extending its entire length and supporting the whole frame.

Keelsons. Vertical stringers extending from stem to stern on the inside of the ship's hull. They are placed over the keel to strengthen it.

Larboard. The left-hand side of the ship when one faces the bow; port.

Launching. The operation of sliding a ship from the building way into the water.

Lay out. To transfer marks from a template to a plate or shape. Also to mark lumber or steel for working.

Lay-out table. A steel floor on a cement foundation upon which articles are measured and marked in the machine shop. The surface is covered with vertical and horizontal lines.

Lift a template. To make a template by fitting the wood to some particular part of the hull.

Lineman. A first class workman in the mold loft who trues up the plans on floor, scrieve board, or table.

Loftsman. A man who lays out lines to make molds for a ship.

Magazine. The room in which ammunition is stored.

Main deck. The uppermost deck of the main hull.

Manhole. An opening, round or oval shape, in a bulkhead, tank top or other partition. It is large enough for a man to pass through, and is closed by a cover held in place by bolts or clamps.

Manning a ship. To equip a ship with a sufficient force of men capable of handling the ship in service.

Marking hammer. A tool for marking rivet holes with paint.

Mast. A long spar, set nearly vertical, on the center line of the hull.

Merchant marine. The total shipping which a nation has for the purpose of carrying merchandise.

Midship. At the center of the ship's length.

Mold loft. A large room with a smooth finished floor on which the decks, frames, floors, and other parts of the ship can be drawn to full size.

Mold or template. A pattern of a part to be constructed. It is usually made of paper or wood.

Mooring. Fastening the ship by hawsers or cables so that it cannot swing or move.

Oakum. Frayed rope used for calking.
On board. A phrase meaning on the ship.
On deck. When a person is on the upper deck in the open air, he is said to be "on deck."
Outboard. The direction from the center to the outside.
Overboard. Over the side of the ship.

Pinnace. A seagoing vessel of the Elizabethan age which relied on both oars and sails for power. An illustration is the "Black Pinnesse" which brought home the body of Sir Philip Sidney.
Plates. Flat metal sheets of various thicknesses, used for covering the outside of vessels, for decks, and for partitions.
Plate and shape (or angle) shop. Mill where plates and angles are fabricated.
Plating. The outside covering of a deck, a bulkhead, or the ship itself.
Poop deck. A deck built over the after part of a vessel.
Port. The direction to the left when one faces the fore part of the ship.
Porthole. *See* Air ports.
Propeller. The device which drives the ship through the water.

Quarter deck. The rear section of the weather deck.
Quarters. The living compartments of the officers and crew.

Rig. A support or brace for a drill.
Rigging. The ropes, wires, and lashings which support the masts, smoke stacks, derricks, king posts, and boat davits. It is sometimes used to refer to the placing on board and the handling of heavy weights and machinery.
Roll. The motion of the ship from side to side caused by the waves and other movements of the water.
Rudder. The device by which the direction of the ship's movements is controlled.

Schooner. A small sailing vessel originally with only two masts and fore and aft rigging. At the present time there are vessels of this type with three, four, and more masts. These are designated as *three-masted* schooner, *four-masted* schooner, and so on.
Scrieve board. A board or temporary floor on which the body plan of a ship is laid out.
Shapes. Steel bars of various cross sections.
Sheer. Slope of the deck lengthwise of the ship.
Sheer plan. A side view showing the length of a ship and heights of parts from the keel.

Shell plating. The steel plates fastened on the outside of the hull frames.

Shoring. Timbers placed under the hull to support it while under construction.

Sliding ways. *See* Launching.

Snap rivet. A rivet driven with a snap die.

Spar. A long, round, solid post or piece of timber.

Stability. The freedom of the ship from rolling or its tendency to remain upright.

Starboard. The right-hand side when one faces toward the bow, or fore end of the ship.

Stem. The heavy steel casting extending from the forward end of the keel to the forecastle deck.

Stern. The rear end of the ship.

Stiffeners. Shapes fastened to plates for reinforcement.

Strakes. A line of plates used for covering the outside of the hull. They are attached to the frames.

Tap. To cut threads inside of a hole. Also a tool for tapping.

Template. *See* Mold.

Tomahawk. A tool used to calk a rivet by hand.

Tonnage.

(*a*) Gross tonnage is based on the cubic contents of the hull, with certain arbitrary spaces deducted, and has little bearing on the cargo-carrying capacity of the vessel.

(*b*) Net registered tonnage is gross tonnage, with certain allowances for crew space and machinery space deducted, and has little bearing on the deadweight carrying capacity of the vessel.

(*c*) Deadweight tonnage is what the vessel actually can carry in tons of heavy cargo, plus stores and bunker coal.

(*d*) Displacement is the total weight of the vessel when full of cargo — that is, the weight of her hull and machinery plus her deadweight tonnage.

In round numbers, a ship of 9000 tons deadweight would stand about as follows:

Deadweight carrying capacity	9000
Gross tonnage	5000
Net registered	3000
Displacement	12000

Also used as a general term for shipping.

Waterline. The line on a ship to which the water rises when the vessel is loaded.

Ways. The places where the hulls of ships are constructed and made ready for launching. Also supports for the ship at the time of launching. (*See* page 135.)

Weather deck. The uppermost deck which extends the full length of the hull.

Wharfage. The money paid to use a wharf for loading and unloading cargo.

Wood grating. An open framework or lattice of wooden bars used for floors or over deck openings.

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